AMERICAN MACHINIST

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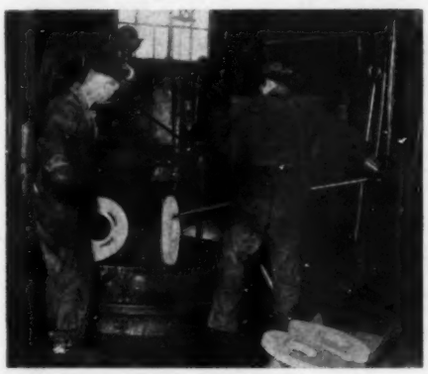

Cast Iron, Too—*So keen is industry to develop the full properties of its materials that cast iron joins steel in the quenching tank (page 860)*

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To help you plan your time at the National Metal Show in Chicago next week we have included as special features:

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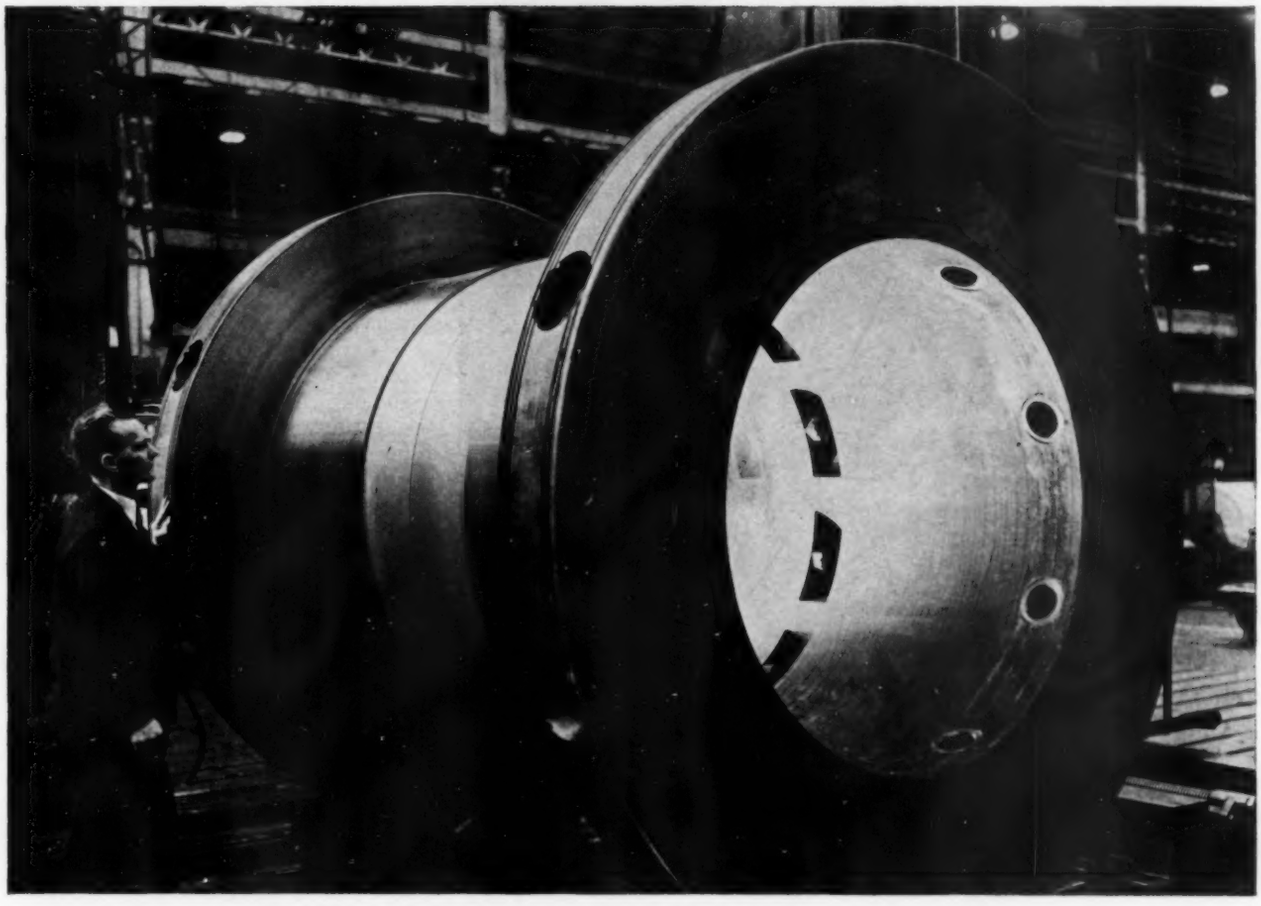
ESTABLISHED 1877 **AMERICAN MACHINIST** BURNHAM FINNEY, Editor



Niles lathe driving head spools, made of two forgings, were flame-hardened

Too Big for Flame Hardening?

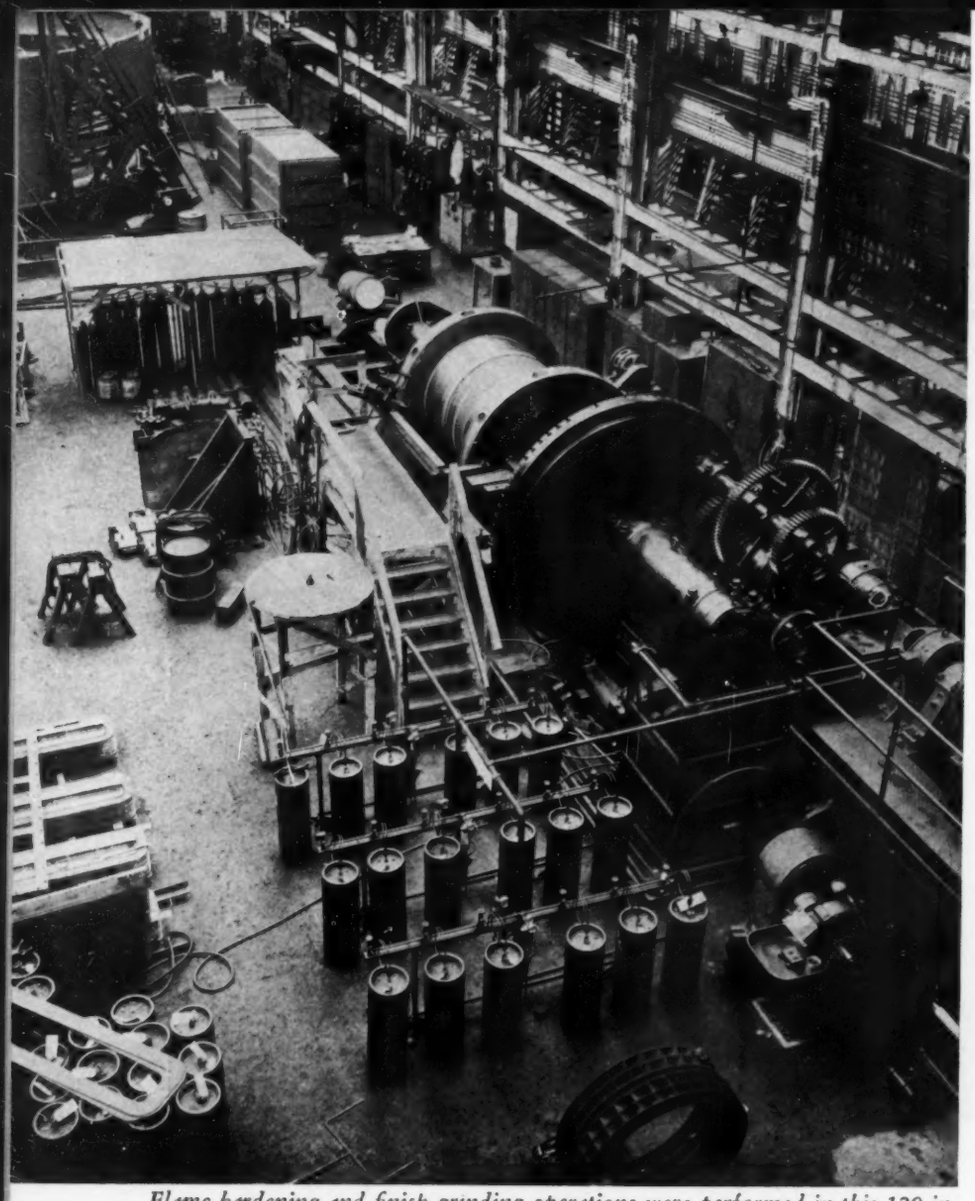
That's what production men wondered when they had to harden some huge lathe parts. But tests on small models revealed a good flame hardening technique, so they tried it. It worked

By L. D. JENNINGS
Manufacturing Engineer, Westinghouse Electric & Manufacturing Company

IN AT LEAST ONE instance oxyacetylene flame hardening has proved to be a flexible, inexpensive method of surface hardening very large pieces. Westinghouse engineers recently were confronted with the problem of surface hardening a number of 44,000-lb. lathe driving head spools for a group of boring machines being fabricated by the Niles Tool Works, subsidiary of General Machinery Corporation, for shipment abroad. The finished spools, which were forged from heavy ingots by the commercial forging division of Carnegie-Illinois Steel Corporation in their Homestead plant, were required to have a hardened surface of from 350 to 500 Brinnell, free from checks, cracks, and chatter marks, yet retain the maximum toughness of the core material.

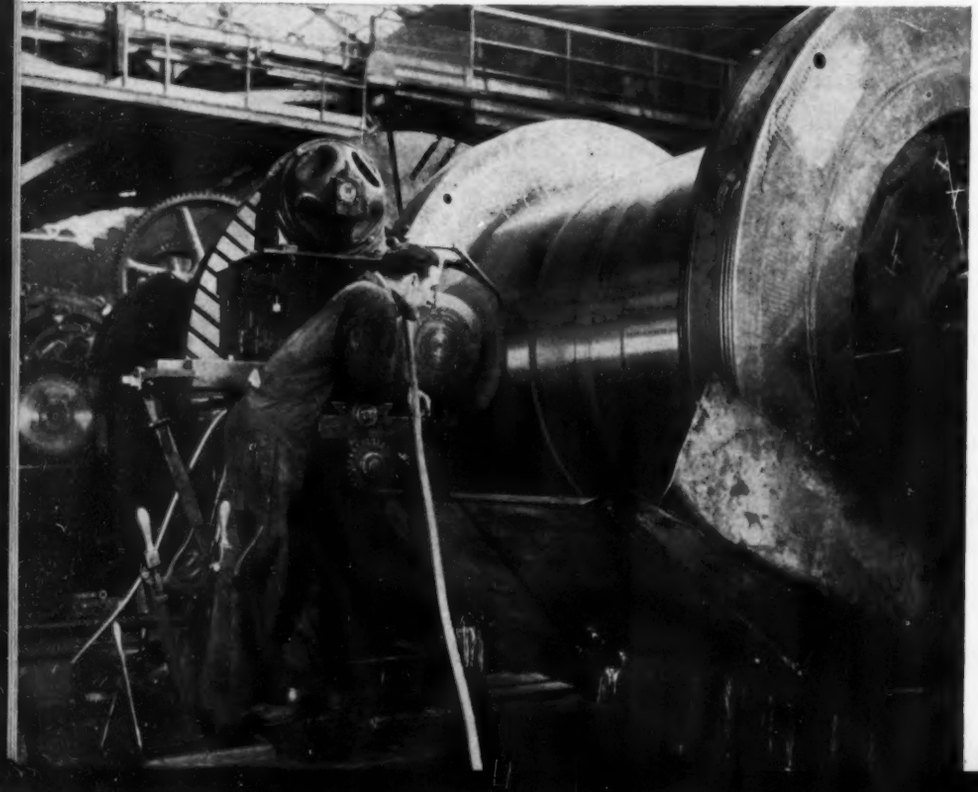
After weighing the several possible methods of hardening, oxyacetylene flame hardening was selected as the most suitable procedure. It provided a flexible method by which the specifications of the contract could be met with a minimum expenditure for hardening equipment, as well as a challenge to the ingenuity of the operators to flame-harden work of such a magnitude.

The spools were fabricated by bolt-



Flame-hardening and finish grinding operations were performed in this 120-in. lathe. Oxygen was delivered to the torches from a 20-bottle manifold, while an 18-bottle manifold furnished the acetylene

The hardened surface was turned, then ground to finished size with a soft fine-grained wheel on a motor-driven head mounted on the lathe carriage



ing together two S.A.E. 1040 coarse-grained forgings. Each forging weighed approximately 22,000 lb., had an inside diameter of 51 in., an outside diameter of 63 in., and an over-all length of 48 in. At one end of the forging was an 8-in. flange, 88 in. in diameter. This flange is the outer end of the spool when two such forgings are joined together to form the center drive spindle.

The equipment necessary to harden the spools consisted of a 120-in. lathe with special low-speed back gears and a variable speed d.c. motor with rheostat; a mandrel to mount the spools, fabricated from a 6-in. shaft; circular plates and rolled cylinders; acetylene and oxygen manifolds; control panel; quenching equipment; flame hardening torches and torch rack.

The oxygen source was a 20-bottle manifold arranged in two sections of ten bottles each so that the operator could use either section or both, as the occasion required. Each section was equipped with a two-stage, heavy-duty regulator capable of delivering 3,000 cubic feet of oxygen per hour. Oxygen from the manifold passed through a common header to a control panel where it was proportioned to the individual torches. Oxygen regulators similar to those at the manifold regulated the pressure for each individual torch.

The acetylene manifold consisted of three six-cylinder manifolds each supplying an individual torch. Each manifold was supplied with a water flash-back arrester open to the atmosphere as well as a mechanical arrester in each pig-tail coil attached to each cylinder for safety. Acetylene from each manifold passed through a heavy-duty regulator to the control panel and from there to its corresponding torch.

Mounted on the control panel were the valves, regulators and gages of each of the three torches to facilitate control of the working pressures. Quenching equipment required a controlled pressure through each torch as well as an auxiliary quench from 10 to 12 in. back of the flame. Valves and gages on the control panel facilitated this operation.

The torches are heavy-duty water-cooled units equipped with mixers, straight extensions, and 4-in. wide flame-hardening tips. They are mounted on "radiograph" arms to secure rapid and convenient adjustment of the torch with respect to the work. The holders are mounted on a cross rail about 10 in. above the horizontal diameter of the spool so that the torch is normal to the work surface and pointing downward at an angle of

about 30 deg. with the horizontal.

Prior to hardening a spool, an experimental thin-walled cylinder two inches thick was forged from the same material as that to be used in the hardened spools. This cylinder was rough machined and placed upon the mandrel in preparation for determining the correct flame-hardening procedure. The pressures of the oxygen, acetylene, and water quench were adjusted to secure ideal torch operation and the desired quench. The cylinder was revolved past the torches at 6, 7, 8, and 9 in. per min. to determine the correct hardening speed. The 6-in. rate produced a surface much too hard, while the 9-in. rate was soft and erratic. The 7-in. rate resulted in a more uniform and satisfactory hardness than the 8-in. rate, so was chosen as the proper hardening rate for the spools to be hardened.

The surface of the trial cylinder was uniformly hard where the hardening rate was 6 in. per min. (600 Brinell), but several long circumnor checking. The depth of hardness was approximately $\frac{1}{8}$-in. and the surface showed no signs of cracking when hit severely with a ball-peen hammer.

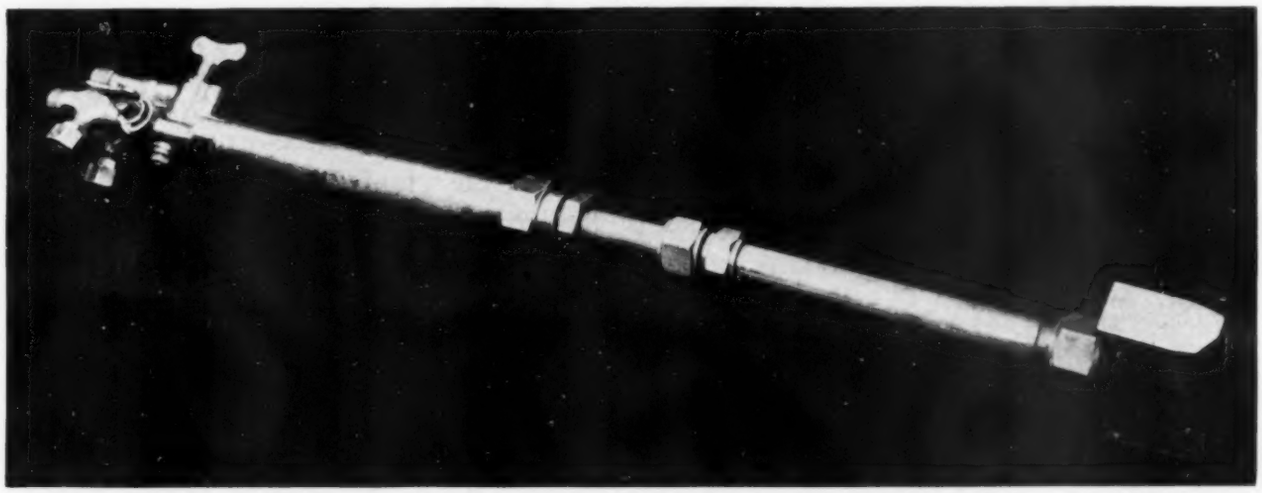
With this information a small test spool was machined 0.030 inch larger than the finished diameter and placed on the mandrel. The hardening operation was very satisfactory, but the spool shrunk during the hardening operation and was undersize at its center. This difficulty was corrected on the future spools by leaving more stock (0.050 in.) on the diameter and only lightly setting the adjusting screws in the flanges of the spools upon the mandrel. The procedure followed in flame hardening a spool was as follows:

The spool was mounted on the mandrel and the speed of rotation was adjusted so that the work surface passed the torches at the rate of 7 in. per min., with the direction of travel such that a point being heated by the torches passes under them through the "blow-outs" will be experienced if the mixer becomes hot. An auxiliary quench must be placed about 10 in. behind the torch, and if the path being hardened is adjacent to a preceding hardened path or a machined edge a stream of water must be plied alongside the adjacent flame-hardening tip.

The work then is started revolving and the torches are lighted. As soon as they are burning properly with a neutral flame, they are moved toward the work surface until the tip of the blue cone is $\frac{1}{8}$ in. from the surface.

As the work passes under the flame, it is quickly raised to an average temperature of from 1500 to 1550 F. by the double row of oxyacetylene flames $\frac{1}{8}$ in. apart at a temperature of approximately 6300 F. As the material continues to rotate, it passes under the spray of water from the rear of the tip and is quickly quenched.

The operator can distinguish a bright red color of the steel after it passes under the flame prior to reach-



The torches used were of a heavy-duty, water-cooled type equipped with mixers, straight extensions and 4-in. wide tips

ferential cracks had developed and much checking was produced. The surface was hardened to a depth of $\frac{1}{8}$ in., but adjacent to the cracks the surface would peel from the core material to a depth of $\frac{1}{32}$ in. as much as $\frac{1}{2}$ in. from the crack.

The result of the first run of the trial cylinder was not very encouraging, but it was concluded that the surface to be hardened was too rough for satisfactory hardening and that the quench was too severe. The hardened surface was removed from the cylinder by machining and the surface ground in preparation for hardening.

The rate of hardening was increased to 7 in. per min. and the pressure of the water quench reduced. The resulting hardness was uniform, between 400 and 450 Brinell, with no cracking

quench. Acetylene, oxygen, and water pressures are adjusted while the torches are in operation. These pressures are important and must be held constant.

The torches are mounted about 10 in. above the horizontal diameter of the spool and normal to the surface at an angle of 30 deg. from the horizontal. Two torches with 4-inch wide flame tips are mounted side by side so that the torch tips are adjacent to each other and their faces parallel to the work. The operator must be able to adjust the torches conveniently in any plane and be able to move the tip of the torches from the work to a point 4 to 6 in. away from it.

A shield must be supplied to prevent the reflected flames from passing around the torch mixer as torch

ing the quench; after the quench, the material has a light gray color. The hardened surface is uniformly hard, free from pits, cracks or checks, and free from oxide or corrosion.

The hardened surface is machined with a special tool and then ground to the finished diameter with a soft fine-grained wheel. The spools were not tempered after hardening, because the hammer test indicated that no excessive stresses remain after 0.025 inch of the hardened surface has been removed by machining.

The surface hardness of a finished spool is remarkably uniform. Narrow bands of soft areas are likely to form between paths of the torches, but these are less than $\frac{1}{4}$ in. wide and are usually somewhat harder than the core material.

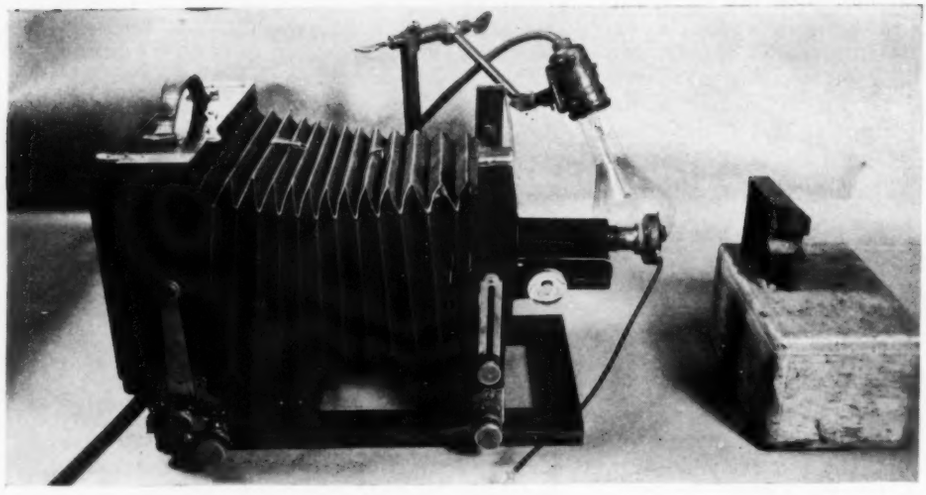


Fig. 1—A view camera with long bellows extension and low magnification lens is used to take two pictures at slightly different angles

Three-Dimension Photos Record Metal Defects

Designed for the amusement of another generation, the stereoscope has been put to work in the laboratory. Here's how it has been adapted to the needs of modern metallurgy

By R. C. GIBBONS
Milwaukee Works, International Harvester Company

Fig. 2—Prints are mounted on cardboard for ready filing and for study with the stereoscope to get three-dimension effect

ABOUT 30 YEARS AGO the stereoscope, with its three-dimension scenic views, helped while away many a long Sunday afternoon; with the passing of the bustle, the fad died out. Now both are coming back.

The stereoscope is being revived both as an amusement and as an aid to scientific investigation. Criminology, geology and biology make use of its principles by the adoption of magnified, three-dimensional views for purposes of record and study.

In our laboratory, considerable work is done in examining metal defects to determine their cause. Part of these, particularly surface defects, pits and inclusions in castings, are most easily identified by their appearance under a low power binocular microscope. Where difficulty of identification is encountered, it is desirable to compare them with similar defects of known cause. The true cause of the defect in the sample in question can then be easily determined and the remedy applied. This makes it advis-

able to keep sets of standard defects always on hand, but because of rusting and storage problems, this is impractical. Photographing the defects at low magnifications and keeping them on file provides a ready and lasting reference source.

For flat objects, ordinary photographs will do, but with such casting defects as pits and surface irregularities, a flat field view does not show the desired appearance. It is necessary to resort to stereoscopic methods to obtain the necessary perspective.

Applying the Principle

In most stereoscopic work, two pictures are taken simultaneously with two cameras placed side by side. Prints from the two negatives are mounted side by side on cardboard and viewed with a stereoscope. The same principle is used in our work, but slight changes were found advisable for magnified views.

The method used in our laboratory simply involves taking two pictures from two different angles with a magnifying camera. An ordinary view camera with a long bellows extension is used, and for magnifications up to about seven diameters, a 75-mm. Micro-Tessar lens gives good results. For higher magnifications a microscope barrel is mounted on the lens board of the camera. Fig. 1 shows this arrangement with the Micro-Tessar used as the objective lens of the microscope. Other lenses used are the 48-mm. and 32-mm. objectives and 4× and 8× projection eyepieces. By using different lens combinations and varying the bellows extension magnifications up to about 40 diameters are obtained. Higher magnifications are possible but present difficulties of focusing. Most of our work has been at from 4 to 25 diameters.

To secure these three-dimension magnified views of irregular objects a picture is taken with the set-up shown in Fig. 1. The camera is then moved through an arc of about seven deg., and another picture taken of the same spot from the new angle. The two negatives are developed and printed and the prints pasted on cardboard with centers 3¼ in. apart. The view can then be examined with a stereoscope, as in Fig. 2, or filed for reference.

The greatest value of these pictures has been the recording of various pits, cracks, fracture types and surface defects, especially in cast iron. Many of the defects found cannot be identified by the usual metallographic technique, and their causes have often been in controversy. Those that are definitely known are photographed and labeled as "shrink pits," "gas pockets," "core blow," "sand inclusion" or other names. Unknown pits are examined under the binoculars and compared with the photographed pits of known cause. Sometimes both are photographed. A conclusion can then be reached as to the probable cause, and steps are taken in the foundry practice to eliminate them.

The standard pictures are also used to train inspectors and the younger foremen so that the most common defects are easily recognized. A reduction in scrap losses has resulted.

This method of study is being expanded to include other materials and such structures as fatigue fractures in small metal parts, especially springs. In several cases this method of study has solved problems that had been causing trouble for some time because of lack of definite knowledge as to the true cause.

Precautions Necessary For Best Results

1. With low magnifications, an angle between photographs of 9 deg. was used, but at higher magnifications, this gave too distorted an image and the angle was reduced slightly.

2. The illumination should be intense and should not be changed between exposures. Otherwise the highlights will be different in the two pictures.

3. Where considerable depth of focus is desired, as in pits and very irregular objects, an iris diaphragm is used in connection with the objective lens and dropped down to give sharper images at all depths.

4. Care should be taken in mounting the prints. Reversing the order, left to right, gives an inside out effect. They should be carefully spaced and parallel to avoid eye strain.

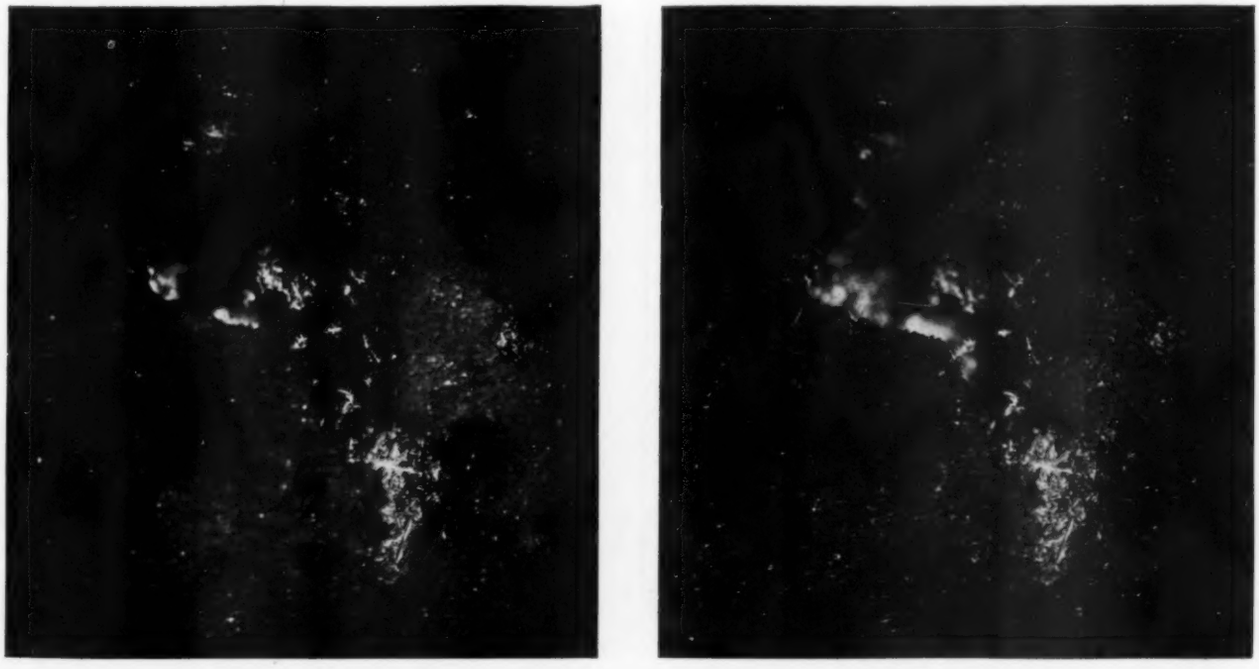


Fig. 3—Get your stereoscope out of the attic and study this double picture of pits caused by liquid shrinkage of cast iron

What Grain Size Means To the Steel User

Fine grain sounds good and does have its advantages; but the job may call for a coarse grained steel. Know why before you specify

By R. W. SIMON
Assistant Manager, Metallurgical Division, Carnegie-Illinois Steel Corporation

BY UTILIZING the information now available on grain size and its control, users of steel subject to processing by heat-treatment can frequently solve many of their problems more efficiently. Grain size alone is not the answer to all problems in the metal-working industry, but an understanding of how it can be controlled and how it affects hardenability and other properties of steel is of value in specifying and working the metal to best advantage.

In soft, low carbon steels the existing ferrite grain size notably affects the properties of the steel as it is finally used. In higher carbon heat-treating steels this ferrite grain size is of much less importance than the austenite grain-growth tendencies and characteristics which are, in part, established by the melting and finishing of the steel. This latter grain size is associated with the high temperature austenite phase of the steel as it exists at elevated temperature, as for example, when ready to be quenched. Correct terminology of grain size has no place for such a phrase as "inherent grain size," for the grain size

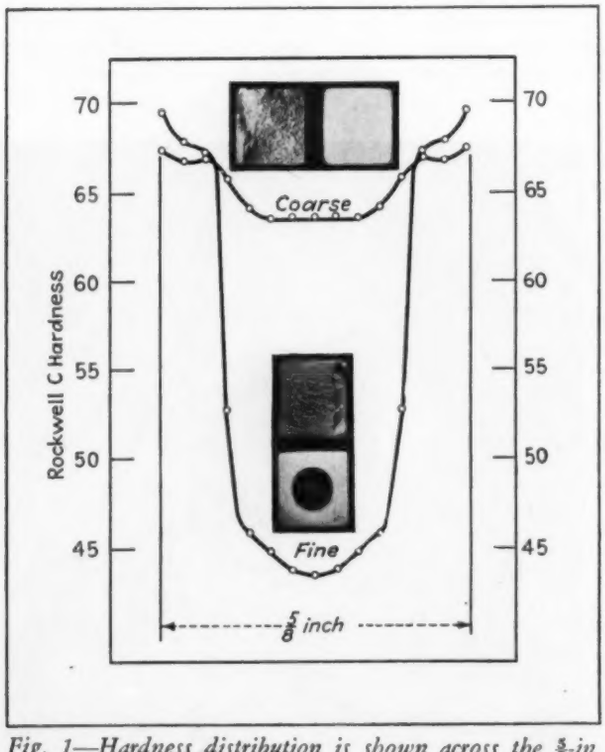


Fig. 1—Hardness distribution is shown across the 5/8-in. thickness of two specimens of the same bar of tool steel; one heated to 1800 F. the other to 1550 F.; both quenched from the same temperature. Inserts show both the fracture and the etched section

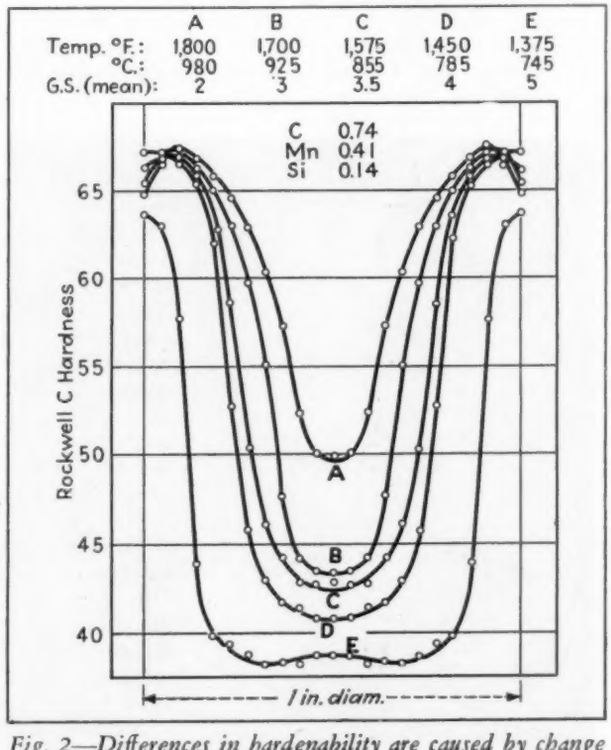


Fig. 2—Differences in hardenability are caused by change in austenite grain size in 0.75 carbon steel. Chart shows hardness distribution across a mean diameter of a 1-in. round. The heating temperature required to develop the indicated grain size is also shown.

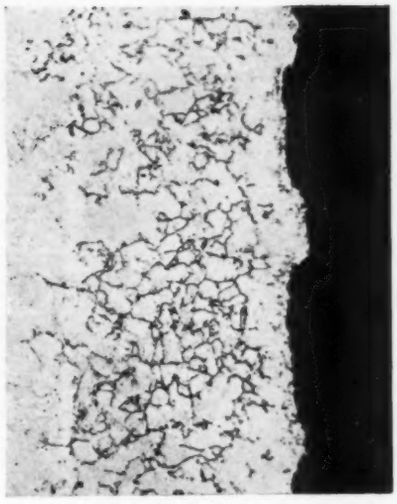


Fig. 3—McQuaid-Ehn test on a piece of steel before normalizing. Magnification: ×100

is dependent upon the heating time and temperature and only broad grain growth tendencies are in any sense inherent.

Long ago steel users appreciated the value of the fracture test as a measure of grain size, but it was not until rather recently that they realized that this fracture grain size of a hardened piece of steel could be brought under control. After all, the user is interested primarily in the properites of the steel existing in the piece as actually used in its final form, and the fracture test indicates quite accurately the size of the austenite (high temperature) grains existing in the piece at the moment of quenching, this structure playing an important part in determining the final properties of the steel.

Influence of Aluminum

Practically any steel, if heated long enough and at a sufficiently high temperature, will become coarse grained. It is true that many highly alloyed steels, like the high-speed steels containing 10 to 20 per cent of elements such as tungsten, molybdenum and vanadium, exhibit a tendency to retain their fine grain size even at relatively high temperatures. But for carbon steels and low-alloy steels, controlling grain size (or restricting the grain growth tendency) has come to mean the judicious use of aluminum in the molten steel. Critical investigation has shown that aluminum in oxygen-free steel does not reduce grain size or hardenability, yet when oxygen is present, suitable aluminum-treated steels take on fine-grained characteristics and permit substantially higher temperatures before coarsening occurs. To take advantage of the influence of grain size, it is essential that the user know the coarsening temperature of the particular type of steel being used.

In heating steel above its upper critical point, the ferrite and iron carbide present react to form austenite which is a solid solution of iron carbide in the high temperature crystal form of iron, the reaction continuing until the entire structure is composed of austenite of a certain initial grain size. Further heating may result in grain coarsening as well as assuring a more uniform distribution of carbon. In the case of non-aluminum-bearing steels, particularly those of the acid open-hearth type, a gradual coarsening begins immediately after the austenite structure is fully established. Starting with a No. 6 grain size at 1500 F., it is not unusual to find that this same steel will show a No. 1 or No. 0 grain size at 1900 F.

Other steels, in which aluminum has been appropriately used, having an initial grain size of perhaps No. 7, will retain this size up to 1700 F. or higher and then coarsen abruptly as the temperature is increased. A short heating period at the coarsening temperature may leave such steels partly fine and partly coarse grained, but longer heating at the same temperature will complete the transition to a completely coarse grained structure.

Grain Size and Hardenability

An outstanding effect of grain size is that exerted upon hardenability. Fig. 1 shows clearly what happens to hardenability when grain structure is coarsened by overheating in one case the bar was heated to 1550 F., establishing a fine grain structure (No. 7), and in the other, by raising the temperature to 1800 F. the grain of the same steel was coarsened to No. 1 size. When both pieces were cooled in air to precisely the same temperature of 1500 F. and then quenched, it was found that the coarse grained sample had completely hardened while the fine grained specimen had developed only a superficial hardness.

Fig. 2 illustrates a similar effect of austenite grain size on the hardenability of 0.75 per cent carbon steel in 1-in. round sections. The range of grain sizes was first developed by heating to temperatures shown and then all specimens were quenched in water from 1375 F.

Melting and pouring practice offers the steel maker the greatest opportunity for controlling grain size and the coarsening temperature may be raised from below 1600 F. to well above 1750 F. by the well advised use of deoxidizers. It is also important to note that the coarsening temperature of steel is dependent to some degree upon the temperature of hot working or normalizing and is modified by cold work. Once the general behavior of the solid steel has been established by the melting practice used, subsequent rolling temperature and heat-treatment can still change the coarsening temperature by 100 to 150 F.

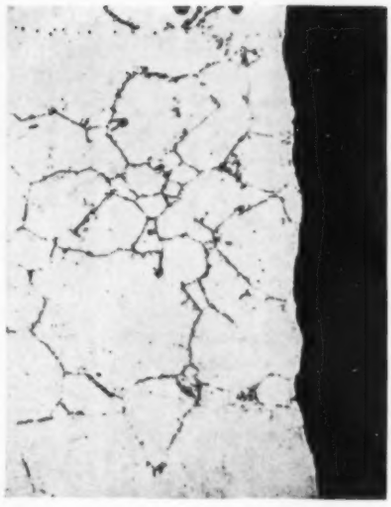


Fig. 4—McQuaid-Ehn test on the same steel as shown in Fig. 3, but after normalizing. ×100.

Effect of Normalizing

Figs. 3 and 4 illustrate the effect of normalizing and at the same time the danger of relying exclusively on the McQuaid-Ehn test as the only measure of grain size. Fig. 3 shows the structure of a piece of carburizing steel after being subjected to the McQuaid-Ehn test, indicating that the steel was fine grained. A piece of the same steel was then normalized and subjected to the same test, with the result shown in Fig. 4. The initial steel developed a fine austenite grain size when carburized at 1700 F. for eight hours, but when carburized after normalizing the grain structure coarsened materially. In the first case the coarsening temperature had not been reached at 1700 F., but in the second instance it had been exceeded at 1700 F. Normalizing, therefore, had lowered the coarsening temperature from somewhere *above* 1700 F. to somewhere *below* 1700 F. The amount of lowering will vary, however, with different steels. It must not be concluded from this example that any steel which is fine-grained in the McQuaid-Ehn test will, if normalized, thereupon be coarse-grained

in this test. The conclusion to be drawn is solely that normalizing lowers the coarsening temperature.

It has been found that different normalizing temperatures affect the coarsening temperature differently, but that the normalizing temperature must be changed substantially to cause appreciable differences. In the case of fine grained steels, having a high coarsening temperature, normalizing from 1,600–1,700 F. will usually lower the coarsening temperature 75–100 F. Furnace cooling, however, does not have nearly as great an effect on lowering the coarsening temperature as does air cooling.

The value of grain size control lies in the influence of known austenite grain size upon the several behaviors of steel. Coarse grained steel is just as beneficial for certain purposes as is fine grained steel for others. Assuming constant compositions, it can be said that coarse grained steels have deeper hardenability, higher tensile strength and better rough machinability than do fine grained steels. These latter steels, however, have many other advantages as will be shown.

Fine Grained for Impact

Fig. 5 illustrates the influence of grain size on the impact strength of fully hardened and tempered tool steel. Small diameter (0.180 in.) specimens were selected to assure that all the austenite transformed to martensite (or became fully hardened) when the samples were quenched, and every precaution was taken to assure that the only variable in the series of tests was the grain size developed by heating. Although the contrasts are not as great in the case of alloy steels because of the effect of the alloying elements, the superior toughness of the fine grained steels is still evident, even in the heavier sections.

Further, warping and dimensional changes during hardening are reduced in steels having a fine austenite grain size and quenching cracks do not occur so frequently. These results are probably due to the lower internal stresses found in the fine grain structure. When austenite of known grain size is permitted to transform to pearlite (as in annealed or normalized steels), it is observed that the coarser grained material produces a somewhat harder product and one which ordinarily machines better. The larger, more regular colonies of pearlite found in steels having a large austenite grain size seemingly reduce the plasticity of the material, and therefore improve its rough machinability, the chips breaking better above the cutting tool instead of clogging cut.

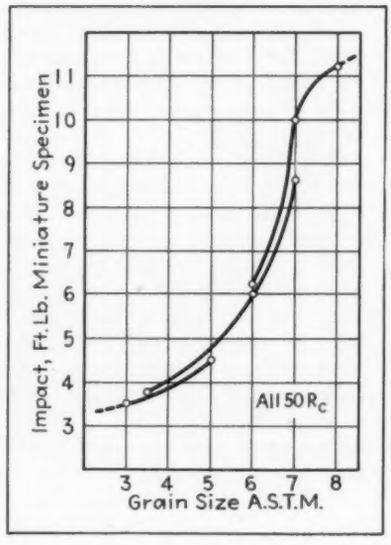


Fig. 5—Influence of grain size on the impact strength of fully hardened and tempered tool steel is shown for 0.180-in. round specimens. Three heating temperatures applied to three steels supplied the assortment of grain sizes

The grain growth characteristics of a given steel may frequently be utilized to good advantage by normalizing the steel, before machining, at a temperature which definitely coarsens the grains. After machining, when the piece is heated for hardening, a finer grained structure can be re-established, thereby securing both good machinability and final toughness. Care must be taken in selecting steels of this type to make sure that the steel can be made to coarsen only above the hardening temperature, but below the normalizing temperature. While such heat-treatment is advantageous, its cost must be balanced against the reduction in machining cost.

Coarse Grained for Machining

The effect of tool form and setting has such an important effect upon machinability that it becomes difficult to express in a few words the part grain size actually plays in the problem, particularly as the effect of plasticity of the metal is frequently masked by the action of the machine tool. However, assuming that the tools are properly shaped and set, when heavy cuts are to be made and the degree of smoothness of the surface is not too important, a coarse grained steel is usually preferred. The use of such a steel usually results in long tool life between grindings, which is particularly important in mass production operations, and by proper tool design a reasonable degree of smoothness can be attained on the finished surface.

If, however, a high degree of smoothness is essential on the machined surface, or if the conditions are such as to make it impossible to set up the most desirable conditions as to tool rake, clearance, etc., fine-grained steels may frequently prove more satisfactory than coarse-grained steels. Each case must be studied individually.

Impact strength in the hardened state increases in inverse proportion to austenite grain size. Tensile strength and yield point are less affected by grain size than is impact strength. Wear resistance, however, depends more upon the composition of the steel than it does on the austenite grain size. The outstanding benefit from fine grain size in steels to be heat-treated lies in the superior toughness of the steel. This means the possibility of higher strength at the same toughness or greater toughness at the same strength.

Final Size Counts

Users may take advantage of the metallurgical control exercised by the steel maker and specify a fine grain type of steel on occasion to permit of a wider range in heat-treating temperature so that the steel will not coarsen in the event that specified temperatures are unintentionally exceeded in hardening. This is particularly important when the piece has enhanced value due to costly work already having been performed upon it. In specifying grain size, however, the user should appreciate also that it is usually the grain size established in the final heat-treatment that really counts and generally not that shown by the McQuaid-Ehn test except, of course, in steels for carburizing. All factors must be considered, and usually an advantageous compromise results. In some cases machinability is more important than toughness and so coarse grained steel is used; in others, highest impact resistance at high strength is essential, and consequently fine grained steel is favored. With the steadily increasing fund of information available, it is now becoming easier for consumers to select steels for special purposes so as to combine various required properties.

The author wishes to express his appreciation of the helpful cooperation of Dr. E. C. Bain, assistant to the vice-president in charge of research and metallurgy, United States Steel Corporation, in making available valuable data and the illustrations used in this article.

Welding With Stainless

Benefits of stainless steel and welded construction can now be combined in a single product. Arc, resistance and gas methods are all available

By V. W. WHITMER
Welding Engineer,
Republic Steel Company

SEVERAL years ago welding was confined to low carbon, soft steel. Today we are welding various steels and alloys which, not many years ago, were considered unsafe or impractical. Proper joint design, more careful selection of type of welding, higher quality filler metal or electrode, improved welding procedure and more satisfactory annealing or heat-treating have helped to overcome the early difficulties.

The stainless and heat-resisting steels all contain basically a high chromium content; that is, in excess of 10 per cent chromium with or without nickel, molybdenum, silicon and other alloys. For convenience in welding, they should be divided into two general classes—those containing chromium with less than 5 per cent nickel (straight chromium types) and those with chromium and 7 per cent or more nickel (chromium-nickel types).

All of the stainless alloys are satisfactorily welded so far as strong, solid joints are concerned, by any of the commercial welding processes except forge or fire welding. They can be gas or electric arc welded with either the metallic or carbon electrode. Resistance processes such as spot, seam, butt and flash, work very well, as do atomic hydrogen and the "Unionmelt" process. Forge welding, however, is unsatisfactory because of formation of a refractory scale on the surfaces during heating.

Chromium alloys are resistant to scaling or oxidation up to the fusion temperature, though they will oxidize rapidly after melting if any air is accessible. Hence, the molten metal must be protected from the air in any fusion welding process, either by a slag such as welding rod coating or a gas blanket in gas welding.

The chromium types containing low carbon (about 0.12 per cent or under) are magnetic, cannot be materially hardened by heat-treatment, have a low coefficient of expansion slightly less than soft steel, are subject to a grain growth at temperatures above 1600 or 1700 F. Furthermore, they are inclined to become brittle after welding, although their toughness can be improved by proper welding and annealing.

There are some applications, where operating conditions permit, greater economy or some other consideration may favor the use of the straight chromium alloys. In view of the physical and welding characteristics, the joints should be fitted up as well as possible, allowing sufficient opening to permit complete penetration, but depositing no more metal than necessary in order to keep the area of reduced ductility to a minimum. Heat should be maintained as low as possible, and thin string beads are preferred to heavy wide layers. Butt welds are much better than lap welds, and complete penetration should be obtained. When sections are heavy, such as about $\frac{3}{16}$ in. or over, welding should be from both sides, scarfing when necessary at 60 or 90 deg. total opening or some other convenient form. Butt welds distribute any loading much more evenly than lap welds and are preferred where the equipment will be subject to both stress and corrosion in service. Joints should be so placed as to avoid all stress possible on cooling because cracking might develop from excess

stress accompanied by low ductility. Corner welds should be avoided and sections flanged to permit butt welds along the straightaway.

The welding rod or filler metal is generally of the same analysis as that of the plate being welded, in order to meet the same service requirements. Occasionally a chromium-nickel rod of the 25–12 or 25–20 type is used to develop greater toughness on the weld metal. This is especially true in the lower chromium ranges which are more susceptible to air hardening and are more likely to crack on cooling before annealing.

The ductility in the sheet or plate falls off rapidly as the temperature is reduced to around the freezing point or lower, although it is moderately tough at room temperature or at 100 or 200 F. It may be advisable in some cases, therefore, if the weather is cold and the metal temperature low, to remove the chill before welding. It is not necessary to preheat to 400 or 500 F., as with some materials, but merely to remove the chill. Although the straight-chromium alloys are not recommended for welded structures where any loading is involved, considerable quantities have been used in tank work in the chemical industry and a number of plants have worked out welding procedure and heat-treatments to develop satisfactory physical properties.

The chromium-nickel types, of which the familiar "18–8" is the most common, are by far the most widely used in welded construction. They are tough and ductile in the as-welded condition and cannot be hardened by heat-treatment. They are non-magnetic and are annealed dead soft by quenching in water from 1950 F. They have a coefficient of expansion higher than mild steel and do not lose their toughness even at very low temperatures. Chromium-nickel types are subject to carbide precipitation in certain temperature ranges, sometimes resulting in intergranular corrosion under severe conditions if the carbon content is over about 0.08 per cent. This is remedied in thin sections by holding the carbon under 0.08 per cent or by the addition of titanium or columbium as stabilizing agents.

Joints should be designed and located in the same manner as with straight chromium. Penetration should be complete. On heavy sheets or light plate work, a good plan is to fit up and tack weld from the back, then line up both edges flush, weld the inside and reinforce the opposite or backside where originally tack welded. This will permit clean, even surfaces for welding, which are to be ground and polished later. Jigs or fixtures are desirable in production work but, for general custom-built tank work, they have not proven efficient. It is impossible to obtain close contact on hand or roll formed sections and unless a tight fit is obtained the value of a jig is wasted. The above tacking and welding procedure has been more satisfactory as well as more economical.

When the low carbon or stabilized types are used, the equipment is generally put in service as welded and without additional heat-treatment, depending on operating conditions. If the design is such that considerable locked up stresses are developed during forming and welding, it may be necessary to anneal the completed job. A full anneal is obtained by rapidly cooling from 1900 to 1950 F., either in an air blast or water spray or other convenient means, depending on facilities available. The surfaces should be cleaned free from scale by sand blasting or pickling or both and passivated in nitric acid to develop a better surface for corrosion resistance.

Arc Weld Has Wide Use

Metallic arc welding, using flux coated electrodes, is used most extensively in general tank work for the chemical, process, food, dairy and other industries where a high polish often is necessary for maximum sanitation or corrosion resistance; also, for building up surfaces as tube sheets and runners, where surface corrosion is encountered and heavy sections are required for strength. The coating should stabilize the arc, protect the metal from oxidation until solidified, and not increase the carbon of the weld metal.

The total heat should be held to a minimum and small beads deposited in line rather than weaving. Slag should be completely removed before further welding. Better results are usually obtained by pulling rather than pushing the arc, although this is left to the judgment and experience of the operator.

Gas welding is most desirable on light gages such as 18 gage and thinner. The flame should be small and just slightly reducing to assure sufficient protection from oxidation of the weld metal. Too much acetylene will weaken the weld. Use clean bare filler rod and do not puddle the weld. Keep the rod in the influence of the flame to prevent burning the end and becoming trapped in the weld metal. Apply water paste of flux on the underside and, if desired, on the top also. This will protect the under side and also act as a mold to secure better penetration and smoother metal, a particularly desirable quality if the surface is to be further polished. Thin gage trim, cabinet tops, exhaust stacks, etc., are good examples of gas welding. Although it can be used on heavier gages, the additional heat may cause more warpage and, hence, gas welding is usually confined to light sheet metal work.

Electric resistance welding is almost a necessity for the very light gage and high tensile stainless used for mobile equipment and will undoubtedly be a big factor eventually in aircraft just as it is today in high tensile, light weight alloy car construction. It is used extensively in low cost, high production items, of which the stainless steel refrigerator evaporator is an excellent example, embodying as it does spot, seam and projection welding. Seam welding is also used extensively in package equipment, where tightness is a factor, such as shipping drums either solid or lined. Flash and butt welding has worked out very well on drums and decorative applications where the weld surface is either trimmed or further polished.

Atomic hydrogen is probably the most satisfactory method of welding where smooth surfaces are required and where grinding or other finishing is impossible such as shipping containers for food products and beer barrels. By butting the edges tight together and with a protected atmosphere on the inside, an excellent joint is obtained by simply fusing without additional filler rod and pickling as a finishing operation. It can be used for both hand and automatic operation to good advantage.

Considerable improvement has been made in the process known as Unionmelt, and it is working out very well on high quality production work on automatic equipment. The weld metal is protected with a heavy slag blanket during and after welding, and sound welds are obtained.

It is often desirable to construct unfired pressure vessels according to the Boiler Code Specifications. Although some equipment has been built and several cases have been handed down, the various stainless types are not as well covered as they should be. This is a live subject with both producers and consumers, and it is hoped rulings soon will be issued covering various types of 18–8 and its modifications for pressure vessels within certain limits.

Quenching Equipment

Courtesy of The Carpenter Steel Company

FRESH-WATER QUENCHING BATH. A still bath of fresh water is not an ideal medium for quenching tool steel. Fresh water dissolves large quantities of gas from the atmosphere, and when a tool is immersed in the bath, the boiling action throws this gas out of solution and it settles in the form of bubbles on the surface of the tool—especially in holes or recesses. This is how soft spots are formed, and the internal strains of such non-uniform cooling are quite likely to crack or badly weaken the tool.

BRINE QUENCHING BATH. When common rock salt is dissolved in fresh water, it largely prevents the water from dissolving atmospheric gas. This is the sole and only reason for adding the salt. The brine "takes hold" and "wets" the tool all over immediately, so that quenching proceeds uniformly. Brine also throws the scale better than fresh water, and yields cleaner tools.

Rock salt can be dissolved in water up to about 26 per cent, which is called a saturated solution. Special hydrometers called salinometers, similar to those used for testing a storage battery, are available for measuring the concentration of brine solutions. See the accompanying table.

The more salt added to the water, the less air it is able to dissolve. Therefore, it might be expected that the best quenching solution would be one saturated with salt. However, the more salt there is, the *slower* the solution will quench, and a saturated solution quenches so slowly that a water-hardening steel can scarcely be hardened in it. Therefore, it is necessary to strike a compromise, and the most satisfactory brine bath will contain between 5 and 10 per cent of salt (about 20 to 40 salinometer reading.) This is by far the most desirable coolant available for quenching water-hardening tool steels in a still tank.

CAUSTIC-SODA QUENCHING SOLUTION. A 5 per cent solution of caustic soda in water is one of the fastest and most efficient quenching baths available. It has the objection of being corrosive to the clothing and hands of the workmen. This bath is seldom used and is rarely necessary.

TEMPERATURE OF THE BATH. Best and most uniform results will be secured if a water or brine bath are kept between 70 and 100 F. the year round.

OIL QUENCHING BATHS. These are used for quenching high-speed steel and other oil-hardening tool steels. A good quenching oil should have a high flash point—about 350 F. or higher—to avoid unnecessary fire hazard. It should have a low viscosity so that it will circulate freely past the tool during quenching, and drain off well when the tool is removed. The oil should not change composition by oxidization or as a result of heating so that its quenching characteristics may remain constant. It should be an oil that is difficult to emulsify; some oils can actually take up water in considerable quantities and cause all sorts of quenching difficulties. Finally, it is preferable to have an oil without a disagreeable odor. These properties are well combined in some of the proprietary brands of prepared quenching oil now on the market.

The oil flows more freely when it is slightly warm and will do a good job of quenching up to about 10 F. Where large quantities of work must be handled, the oil is frequently circulated through cooling coils. However, the arrangement shown in the drawing will serve very well in most tool hardening rooms. On cold mornings, if the oil is a little thick, it is well to heat it up to 90 to 100 F. with pieces of hot iron.

MOLTEN SALTS OR METALS FOR QUENCHING. These are rarely used excepting perhaps for high-speed steel. Their purpose is to permit of fairly rapid cooling down to the temperature of the hot bath and then employ a slower rate down to room temperature. Tools so quenched must finally be cooled below 200 F. and then drawn just the same as though they had been quenched in a more normal fashion.

ARRANGEMENT OF QUENCHING TANKS. The drawing shows the essential elements of a good quenching layout. The large tank is filled with fresh water which serves to cool both the brine and the oil. Water is admitted through a vertical standpipe—sometimes called a "bubbler." With this water flowing, certain types of tools can be quenched in the upstream of the bubbler with little danger of gas pockets.

It is important to note the nipple at the bottom of the bubbler pipe. This is to permit the connection of flushing equipment used to quench actively certain surfaces of a tool and retard the quench on the other surfaces.

The water overflows through a standpipe at the right. Provision must be made to hold the water level at any point desired, because many types of flushing apparatus do not operate beneath the surface of the water—they must be out in the air. The water level is controlled by using overflow pipes of different lengths.

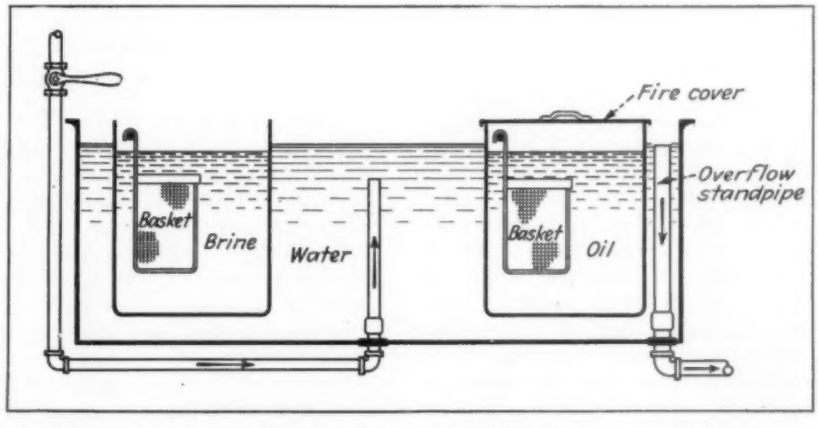
The oil quenching bath should be provided with a snugly fitting cover to extinguish fires which can always occur in a busy hardening room.

The baskets are useful for holding hardened tools during the short interval before they are drawn. Below the surface of the liquid they are protected from sudden temperature changes that might strike them in the air.

SALT BRINE SOLUTION

Salinometer reading	Per cent of salt	Pounds of salt per gal. solution	Degrees Baumé
0	0.00	None	1.00
10	2.65	0.22	2.60
20	5.30	0.46	5.20
30	7.95	0.70	7.80
40	10.60	0.95	10.40
50	13.25	1.21	13.00
60	15.90	1.48	15.60
70	18.55	1.76	18.20
80	21.20	2.05	20.80
90	23.85	2.35	23.40
100	26.50	2.66	26.00

Note:— Salinometers and hydrometers are usually calibrated to test brine solutions at 60 F. Hot solutions will give somewhat lower readings—roughly one point on the Salinometer for each 10 F. rise in temperature. For example, a 10 per cent salt solution would read about 37 on the salinometer at 65 F, and about 35 at 85 F.



In this convenient quenching layout for a tool-hardening room, the fresh water can be adjusted to any desired level, which adjustment may be necessary when using flushing equipment that must be operated in air. The flushing equipment is used to quench actively certain surfaces of a tool and retard the quench on other surfaces

Meehanite castings can be subjected to eight different heat-treatments. Ordinary furnace construction is sufficient

Making the Most of Meehanite

Properties of Meehanite iron castings can be adjusted through heat-treatment to suit service conditions

By C. E. HERINGTON
Meehanite Research Institute of America

MEEHANITE is a processed cast iron produced under rigidly controlled metallurgical conditions and can be used in the construction of all types of machinery and industrial equipment. It responds readily to heat-treatment and permits the achievement of high physical properties accompanied by either hardness or machinability. Properties required by individual service requirements can be "built into" Meehanite castings. For example, where the problem of distortion is important, castings may be treated so as to be free of internal stresses.

There are eight different heat-treatments which may be applied successfully to Meehanite castings, as follows: (1) Annealing for stress relief, (2) annealing for machinability, (3) toughening, (4) malleablizing, (5) carburizing, (6) nitriding, (7) coating, and (8) quench, or quench and draw.

Stress relieving of Meehanite is carried out at temperatures ranging from 850 to 1,150 F., depending upon the density of the iron. In this treatment, care must be taken to see that the casting is not overheated. This causes a marked deterioration in internal structure with a resultant loss of strength.

It has been found that one hour per inch of section at 1,100 F. will remove any stresses present in the casting. This temperature will cause only a very slight drop in tensile strength and hardness. This stress relieving treatment accomplishes the same results as the old process known as "aging" formerly accomplished by exposing iron castings to weather temperatures for a period of from six to eight months.

Machinability anneals are performed just below or within the criti-

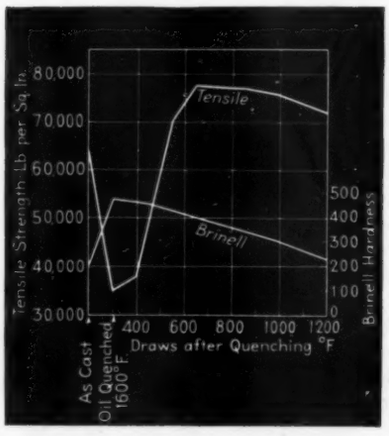
ical temperature range, and care must be taken during the process to prevent excessive graphitization and loss of strength. Complete anneals will result in a soft low-strength iron and should be avoided. Temperatures for this treatment depend upon the type of Meehanite being used, but for the general engineering grades consist of annealing for one hour in temperatures ranging from 1,300 to 1,380 F.

Annealing vs. Normalizing

This annealing treatment should not be confused with normalizing, which term sometimes is used to express the same idea. Actually, however, normalizing is heating to above the critical temperature range, followed by cooling to below that range in still air at ordinary temperatures and then re-introduction into a furnace, the temperature of which is below the critical range. Final cooling is performed gradually to room temperature. This treatment is rarely, if ever, necessary with Meehanite.

Toughening heat-treatments are given such products as grate bars or liners made from a "White Meehanite" which is inclined to be more or less brittle. The treatment consists of heating the castings from 1,350 to 1,650 F. for one to five hours, depending upon the analysis of the iron. This treatment then is followed by furnace cooling, which precipitates enough graphite to allow handling and installation of the castings without breakage.

Malleabilizing of Meehanite castings, as in the case of annealing for machinability, should be carried out only upon the correct type of Meehanite when the iron has a total carbon analysis of less than 3 per cent.



Theses two curves indicate the effect of heat-treatment on hardness and tensile strength of Process GA Meehanite castings having an average 2-in. section

ENGINEERING PROPERTIES OF MEEHANITE

Properties	General Engineering Type GA	Heat-Treated Type GAH
Tensile Strength — lb. per sq. in	Over 50,000	Over 70,000
Modulus of Elasticity	21,000,000	28,000,000
Transverse Strength (1.2 Bar — 18 Centers)		
Load — Pounds	3100–3600	3800
Deflection — Inches	0.30–0.36	0.45
Modulus of Rupture — lb. per sq. in	88,950	.....
Compressive Strength — lb. per sq. in	175,000	250,000
Fatigue Strength — lb. per sq. in	22,000	28,000
Impact Strength — Charpy — ft. lb	6.9	11.0
Ultimate Torsional Strength		
Fibre Stress — lb. per sq. in	61,000	.....
Degrees Twist	98.7	.....
Shear Strength — lb. per sq. in	48,000	.....
Damping Capacity (20,000 lb. per sq. in. Torsional Stress)		
Energy Dissipated 1st Cycle	24.0%	.....
Brinell Hardness (as cast)	207 and up	250 to 600
Coefficient of Thermal Expansion — Per deg. F. from 100 to 1,000 F	.00000687	.....
Machinability Rating — Dalcher	48	.....
Yield Point — lb. per sq. in	45,000	60,000
Elastic Limit — lb. per sq. in	21,000	50,000

In this treatment, the piece is heated from 1,700 to 1,750 F. for one to three hours and then cooled slowly to the critical temperature range. From this point the casting is either oil quenched and tempered, air quenched, or cooled slowly in the furnace. Proper treatment of this type permits the achievement of strengths comparable to oil quenched and drawn castings together with a comparatively low Brinnell hardness. This method is not, however, adaptable to castings that have considerable variation in section.

Carburizing Seldom Used

Meehanite castings seldom are suggested for a carburizing treatment, the exception being small castings that may be packed in bone-black enclosed pots. In this case the pots are heated at 1,700 F. for four hours, cooled, and the castings re-heated to 1,475 F. in a lead bath for twenty minutes. They then are quenched to 350 F. and place in hot oil for one hour. The treatment gives improved wear resisting qualities, but the same or better results may be obtained by straight quenching and drawing.

Nitriding of Meehanite is still in the experimental stage. The process consists of passing ammonia gas over the casting for a long period, while the casting is kept at a temperature of 1,050 F. The extremely hard and unmachinable surface given a casting by this process is seldom required in an iron casting.

Meehanite castings may be subjected to blueing, blacking, or galvanizing treatments in cases where the service requirements of the finished product demand such treatment.

Blueing is effected by heating the casting in a bath consisting of equal parts of sodium and potassium nitrates, the bath being at a temperature of 900 F., followed by oil quenching.

Blacking is done by heating the castings to 1,200 F., with a carbonizing material in pots, followed by quenching in sperm oil.

Ordinary methods of dip galvanizing are applicable and are performed at temperatures of from 775 to 800 F.

For quenching and drawing Meehanite, the castings are slowly heated to 1,000 F. and then quickly heated to 1,550 F., held at this temperature for twenty minutes per inch of thickness, and then quenched in oil or water—preferably oil. The casting then is drawn; draw temperatures depending upon the hardness or tensile strength required. An accompanying table shows the results of draws at different temperatures on castings having an original tensile strength of 52,000 lb. per sq. in.

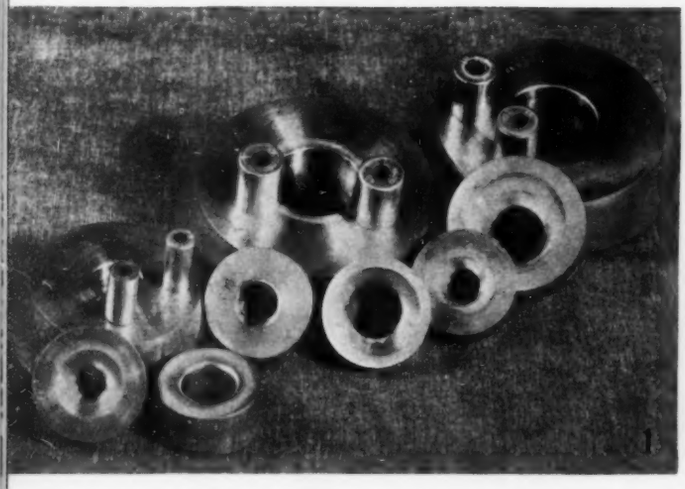
Result of Draws at Different Temperatures on Meehanite

Draw Temperature	Strength	Brinell Hardness Number	Charpy Impact
570 F.	72,000	450	4.9
750 F.	78,000	430	8.5
900 F.	75,000	335	9.6
1000 F.	73,000	291	9.5
1200 F.	60,000	256	8.4
1300 F.	52,000	234	6.8
1400 F.	47,000	207	5.1

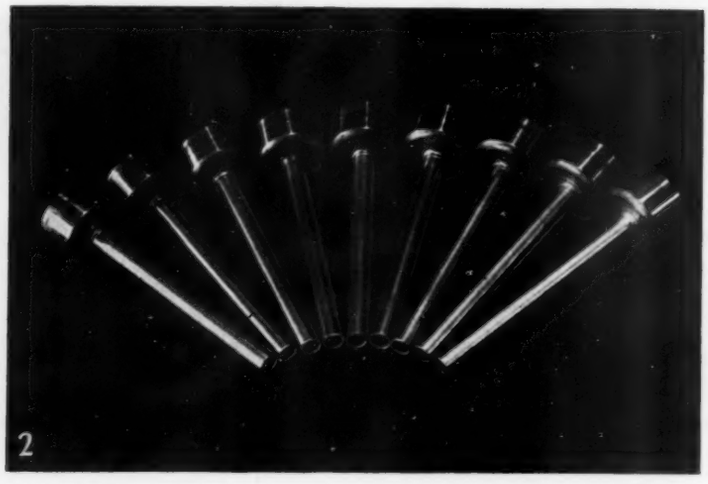
Plated Parts Wear Longer

No longer merely a glitter for the customer's eye, chromium plating takes up the utilitarian job of adding life to machine and tool parts

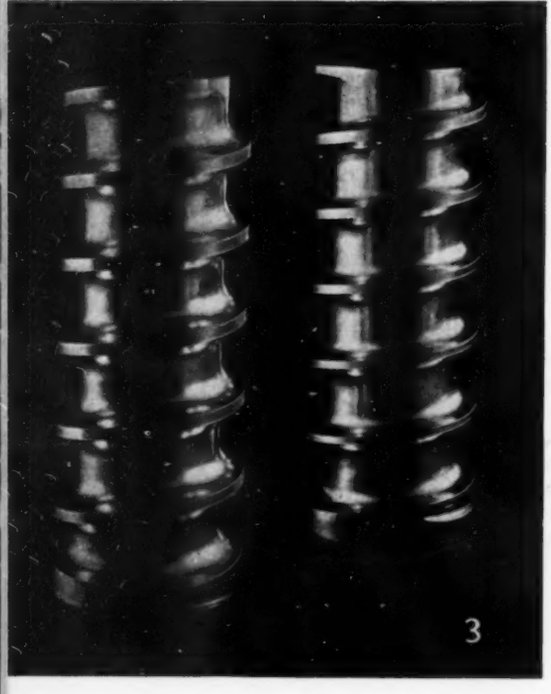
By EDWIN SMITH
Keystone Chromium Company



1. *These tube drawing dies and plugs are used for drawing four different varieties of alloys in as manny different factories. Normal thickness of chromium is 0.0015 in. A large percentage of the tubing produced in the United States is drawn over chromium-plated plugs and through chromium-plated dies*



2. *Valve-grinder spindles. The machine in which these spindles are used is built with the precision of a high-powered optical instrument. Spindles are discarded when the wear exceeds 0.0001 in., yet each will grind several thousand valve seats. Thickness of chromium after grinding is 0.003 in.*



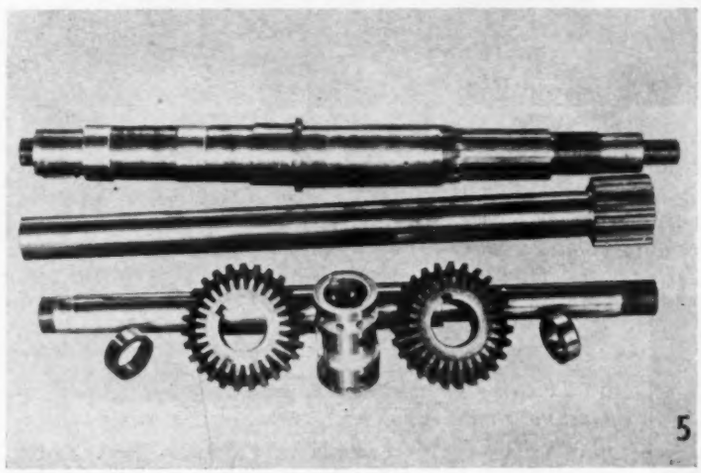
3. *Worms from plastic-extruding machine. The plastic compound extruded by these worms is quite unplastic in many ways. The pressures built up in the machine are extraordinary, and the wear on unplated worms is several thousandths of an inch per day. Those shown are chromium-plated to about 0.010 in. in thickness, and have been working over two years without the chromium wearing through to the steel*

CHROMIUM has been found one of the best wear-resistant materials available to the designer of machines and tools. In a few instances, chrome-hardening has proved the solution of problems which have baffled engineer for years. In many more instances, chrome-hardening has reduced maintenance costs to a fraction of their former value because of the greatly increased life given to the parts upon which it has been applied.

In the early days of chromium plating, some fourteen years ago, little was known about how to make chromium adhere strongly to the base metal. Sometimes a chromium plated part worked well, and sometimes it did not. Engineers gave it up as being too uncertain. Also, in those early days there were plenty of people who thought a thousandth of an inch of chromium would take the place of 30 or more thousandths of case-hardening. Today we know how to make chromium adhere like grim death, particularly to ferrous alloys, and most of us have given up the idea of adding any mechanical strength to a part by depositing a few thousandths of an inch of chromium on the surface.

It all depends on the part and the service expected of it, but generally speaking, the harder the base upon which the chromium is applied the

4. *Labyrinth bushings for high pressure centrifugal pumps are plated with an excess of chromium and then ground. After grinding the chromium is 0.003 in. thick. This amount of chromium has been found to prevent both wear and corrosion on this part employed in a situation where hardened steel wears quite rapidly*



5. *The spoils from six different machine shops in one afternoon. Mismachined parts chrome-salvaged, to be ground to size. The spindle directly behind the gears is now in regular production plated slightly oversize and ground with a net 0.0025 in. chromium. The two little bushings are also production work now with 0.001 in. thickness of chromium plated to size and used without grinding after plating*

6. *Chrome-hardened rams on high-pressure pumps with chromium about 0.005 in. thick are polished but not ground after plating. Water-lubrication is found completely satisfactory during the past three years of use*

better the results obtained from the chromium surface. The irreducible minimum for the successful application of chromium to mechanical parts is that the part must be sufficiently strong or hard to resist mechanical deformation from the stresses normally applied to it. Given a part of this type, application of from a few ten-thousandths to three or four thousandths of an inch of chromium will often reduce wear on the surface to a negligible amount.

Many of the present-day applications of chromium have taken place because of salvage operations on worn or mis-machined parts. As service men found certain parts which did not wear out with accustomed rapidity and investigation showed that they had been chrome-salvaged, engineering departments began to figure on chrome-hardening in production until the application of this process has become widespread in a number of industries.

Hints on Handling Parts for Chromium Plating

Chromium plating affects surface properties only; therefore, the base material must be suited to the purpose intended.

Break all sharp corners and edges, exterior and interior, employing as large a radius as practicable.

Control heat-treating and grinding carefully so there are no surface checks and cracks. A part hardened to the limit may burst during the plating if there are any flaws in the surface.

Grind surfaces to be plated to a fine commercial finish. If the part is to be used without grinding or lapping after plating, the finish, before plating, must be as good or better than the finish required after plating.

Grind chromium-plated surfaces with the special wheels designed for this purpose now made by all the manufacturers of grinding wheels. Use plenty of coolant, and keep the wheel dressed with a diamond. Take light cuts, or the wheel will glaze and crack the chromium and sometimes the base metal too. If normal care is exercised, there is no particular difficulty in grinding a chromium surface.

Spindles, arbors, crankshafts, journals and pins, and most machine parts should have a minimum thickness of chromium of 0.002 and preferably 0.003 in. after grinding.

Dies and mandrels used for forming, extruding and drawing metals succeed best when the chromium is held to a thickness of 0.0015 in. with superficial lapping and polishing after plating.

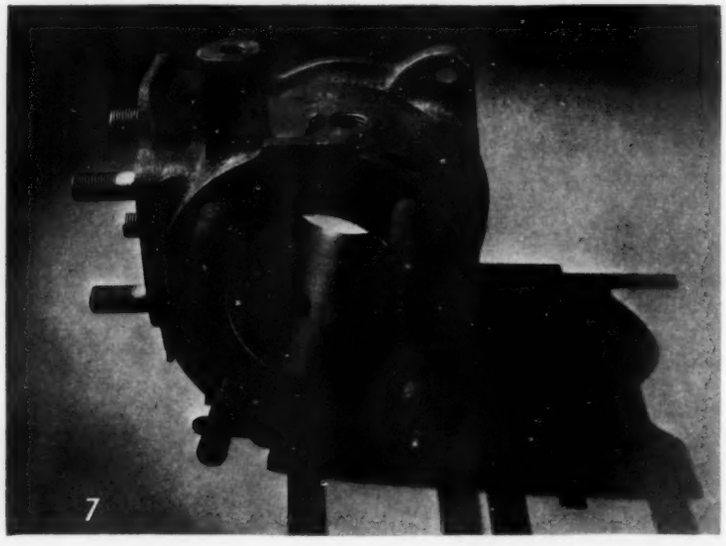
Heavy machine parts, rams, pump-rods, large journals and similar pieces are usually plated with 0.005 in. thickness and polished after plating.

Light-duty parts, particularly if they are rigidly supported so there is

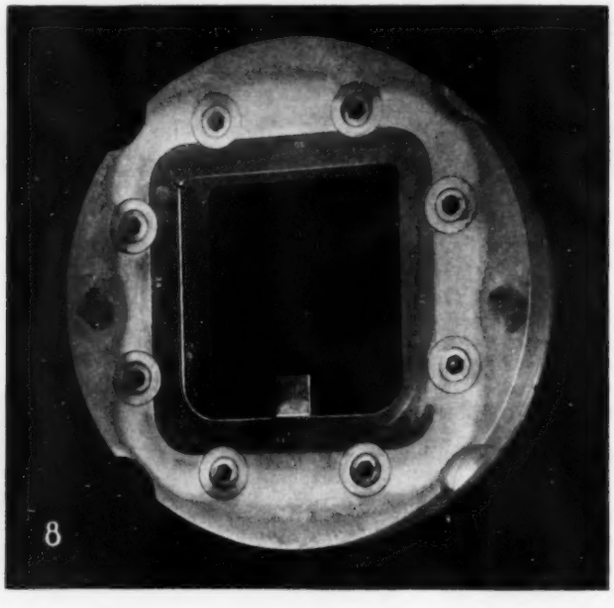
no side thrust, are often plated accurately to size with 0.0003 to 0.0005 in. chromium and used without grinding or lapping.

Cylinders for internal-combustion motors work well with a net 0.0002 in. after honing.

Make specifications absolutely clear. Send a sketch or blueprint to the plater with the part, and make note where you want the chromium and how thick you want it plated.



7. *Outboard motor cylinder. In a hard outboard race an ordinary cylinder may wear as much as 0.006 to 0.008 in. Then the driver is disqualified. A cylinder plated and honed with a net thickness of chromium of about 0.002 in. will frequently outwear three or four crankcases with no appreciable wear; and the rings are said to last several times as long. As in most good things, of course, there is a catch in it—two of them in fact. In the first place, the cylinder must be thoroughly seasoned before grinding out and plating. In the second place it takes about 24 hours turning over with a small electric motor to get the rings to seat. Ask the next outboard racing driver you see*



8. *This ring die with accompanying top and bottom pistons, not shown in the photograph, costs a couple of hundred dollars at least. The material out of which the die makes rectangular briquettes is highly corrosive to steel and an excellent abrasive as well. It was determined at the outset to make the die with removable liners which might be readily replaced. Chrome hardening was also determined on before the machine was built. Chromium plating turned out to be a difficult job. The ring die requires three separate set-ups to plate it, and the pistons two set-ups each. There is no chance for any grinding after plating so the plating must be done right the first time—no beads, no unplated parts. In resistance to wear and corrosion, the chromium surface has exceeded expectations, and when replating is required, it will cost less than a fourth as much as making new liners and pistons*

9. *What a headache this was. Eighteen hardened and ground spindles, and when completed each one 0.003 in. undersize at one bearing point. The original eighteen cost 75 per cent of the cost of new ones to chrome-salvage and grind to size. However, the decreased wear on the chrome-hardened bearing surface was so marked that the manufacturer determined to make chrome-hardening standard. With steady production the increased cost of the part due to chrome-hardening has been reduced to 32 per cent, and the replacement of worn spindles has been reduced to nothing for the past year*

The Working of S.A.E. NICKEL ALLOY STEELS

DEVELOPMENT of many alloy steels has been intimately associated with the development of the automobile. Nickel alloy steels, in particular, have played an important role, because they have high tensile strength and toughness, the ability to resist shock and fatigue, and a high degree of dependability.

Chemical specifications for these steels have been established by the Society of Automotive Engineers to cover a wide range of useful properties. Although often referred to as "automotive steels" they are of value in meeting diverse requirements of many other branches of the metal-working industry.

The nickel steels listed may be divided into two classes comprising: (1) the carburizing steels containing up to about 0.25 per cent carbon, which are used where a hard wear-resistant surface is required, together with maximum toughness or resistance to shock, and (2) oil- and water-hardening steels containing from about 0.25 to 0.50 per cent carbon. The latter are uniform in carbon content throughout and are frequently used where machining is done after heat-treatment to provide smooth, bright, scale-free surfaces with accuracy in dimensions in the finished part.

EFFECTS OF ALLOYING ELEMENTS

Nickel—The effect produced by the addition of nickel:

1. Raises strength without sacrificing ductility; offers shock or impact resistance in minimum sections.
2. Lowers the hardening temperatures, which simplifies heat-treatment, results in less quenching deformation and scaling.
3. Retards critical cooling rate; permits oil quenching; reduces grain growth at elevated temperature.
4. Promotes depth hardening in heavy sections.
5. Intensifies the effect of other alloy elements, particularly chromium.

Chromium—The effect produced by the addition of chromium:

1. Raises the ultimate strength, hardness and toughness.
2. Raises the temperatures for hardening or quenching.
3. Slows up the critical rate of transformation in the steel which explains the capacity for deep-hardening and air-hardening of chromium steels, as well as high hardness at high tempering temperatures and high strength at elevated temperatures.
4. Minimizes grain growth.
5. Increases resistance to deformation and abrasion.
6. Reduces thermal and electrical conductivity.

Molybdenum—The effects produced by the addition of molybdenum:

1. Raises ultimate strength, hardness and toughness.
2. Minimizes grain growth.
3. Broadens range of permissible heat-treating temperatures.
4. Increases the penetrative effect of hardening.
5. Permits the use of higher tempering temperatures after quenchng.
6. Reduces susceptibility to temper brittleness.
7. Contributes to the easy machining of a high alloy steel, particularly in the S.A.E. series of nickel-chromium steel.

Due credit is given the following organizations for data supplied by them toward the preparation of this section:

Abrasive Company
American Society for Metals
American Society of Mechanical Engineers
American Welding Society
E. C. Atkins and Company
E. W. Bliss Company
Carboloy Company, Incorporated
The Carborundum Company
Carnegie-Illinois Steel Corporation
The Carpenter Steel Company
The Cleveland Twist Drill Company
Continental Machines Incorporated
The Eastern Machine Screw Corporation
General Electric Company
The Geometric Tool Company
Gisholt Machine Company
Greenfield Tap & Die Corporation
Haynes Stellite Company
Henry Disston & Sons, Incorporated
The Henry G. Thompson & Sons Co.
E. F. Houghton & Company
The International Nickel Company
Landis Machine Company
The Lincoln Electric Company
McKenna Metals Company
Morse Twist Drill & Machine Company
National Broach & Machine Company
National Twist Drill & Tool Co.
Norton Company
Republic Steel Corporation
Society of Automotive Engineers
Socony-Vacuum Oil Company, Incorporated
The Texas Company
Union Carbide & Carbon Corporation

KINDS OF S.A.E. NICKEL STEELS

CARBURIZING STEELS

The principal nickel alloy carburizing steels are S.A.E. 2015, 2115, 2315, 2320, 2515, 3115, 3120, 3215, 3220, 3312, 3415, 4320, 4615, 4620, 4815, 4820. While the majority of the applications of these steels involve carburizing and quenching as shown in the table of heat-treatments, some of the low carbon nickel alloy steels are also employed for direct quenching and tempering.

The choice of a nickel alloy carburizing steel for a particular application will depend primarily upon the properties and performance desired, but in many instances other factors must also be considered. For the most severe service, the higher alloy steels of the group are to be preferred, such as S.A.E. steels 2515, 3312 and 4815. These resist grain growth in the long high-temperature heating for carburizing and respond well to single-quenching treatment, which hardens the core so as to provide support for the case when it is subjected to heavy service. Hardened in this manner, the cases of these steels will not coarsen enough to develop brittleness but, especially after low temperature carburization, will retain a desirable degree of toughness and show high resistance to surface fatigue and wear. They have excellent depth-hardening characteristics, especially for heavy sections.

CHEMICAL SPECIFICATIONS FOR S.A.E. NICKEL ALLOY STEELS

For these Sheets, Phosphorus = 0.040; Sulphur = 0.050; and Silicon = 015-0.30

S.A.E. No.	Carbon	Mang.	Nickel	Chromium	Moly.
2015	0.10–0.20	0.30–0.60	0.40–0.60	.....	.....
2115	0.10–0.20	0.30–0.60	1.25–1.75	.....	.....
2315	0.10–0.20	0.30–0.60	3.25–3.75	.....	.....
2320	0.15–0.25	0.30–0.60	3.25–3.75	.....	.....
2330	0.25–0.35	0.50–0.80	3.25–3.75	.....	.....
2335	0.30–0.40	0.50–0.80	3.25–3.75	.....	.....
2340	0.35–0.45	0.60–0.90	3.25–3.75	.....	.....
2345	0.40–0.50	0.60–0.90	3.25–3.75	.....	.....
2350	0.45–0.55	0.60–0.90	3.25–3.75	.....	.....
2515	0.10–0.20	0.30–0.60	4.75–5.25	.....	.....
3115	0.10–0.20	0.30–0.60	1.00–1.50	0.45–0.75	.....
3120	0.15–0.25	0.30–0.60	1.00–1.50	0.45–0.75	.....
3125	0.20–0.30	0.50–0.80	1.00–1.50	0.45–0.75	.....
3130	0.25–0.35	0.50–0.80	1.00–1.50	0.45–0.75	.....
3135	0.30–0.40	0.50–0.80	1.00–1.50	0.45–0.75	.....
3140	0.35–0.45	0.60–0.90	1.00–1.50	0.45–0.75	.....
X3140	0.35–0.45	0.60–0.90	1.00–1.50	0.60–0.90	.....
3145	0.40–0.50	0.60–0.90	1.00–1.50	0.45–0.75	.....
3150	0.45–0.55	0.60–0.90	1.00–1.50	0.45–0.75	.....
3215	0.10–0.20	0.30–0.60	1.50–2.00	0.90–1.25	.....
3220	0.15–0.25	0.30–0.60	1.50–2.00	0.90–1.25	.....
3230	0.25–0.35	0.30–0.60	1.50–2.00	0.90–1.25	.....
3240	0.35–0.45	0.30–0.60	1.50–2.00	0.90–1.25	.....
3245	0.40–0.50	0.30–0.60	1.50–2.00	0.90–1.25	.....
3250	0.45–0.55	0.30–0.60	1.50–2.00	0.90–1.25	.....
3312	max.-0.17	0.30–0.60	3.25–3.75	1.25–1.75	.....
3325	0.20–0.30	0.30–0.60	3.25–3.75	1.25–1.75	.....
3335	0.30–0.40	0.30–0.60	3.25–3.75	1.25–1.75	.....
3340	0.35–0.45	0.30–0.60	3.25–3.75	1.25–1.75	.....
3415	0.10–0.20	0.30–0.60	2.75–3.25	0.60–0.95	.....
3435	0.30–0.40	0.30–0.60	2.75–3.25	0.60–0.95	.....
3450	0.45–0.55	0.30–0.60	2.75–3.25	0.60–0.95	.....
4320	0.15–0.25	0.40–0.70	1.15–2.00	0.30–0.60	0.20–0.30
4340	0.35–0.45	0.50–0.80	1.50–2.00	0.50–0.80	0.30–0.40
X4340	0.35–0.45	0.50–0.80	1.50–2.00	0.60–0.90	0.20–0.30
4615	0.10–0.20	0.40–0.70	1.65–2.00	.....	0.20–0.30
4620	0.15–0.25	0.40–0.70	1.65–2.00	.....	0.20–0.30
4640	0.35–0.45	0.50–0.80	1.65–2.00	.....	0.20–0.30
4815	0.10–0.20	0.40–0.60	3.25–3.75	.....	0.20–0.30
4820	0.15–0.25	0.40–0.60	3.25–3.75	.....	0.20–0.30

OIL AND WATER HARDENING STEELS

In general, S.A.E. steels with less than 0.30 to 0.35 per cent carbon may be considered as water-hardening steels in sizes between ¾ in. and 2½ in., while those with higher carbon contents may be considered as oil-hardening steels. In the final analysis, the choice of the quenching medium is dependent upon the alloy content and the size and shape of the piece. Steels with the highest proportions of alloying elements, such as the S.A.E. 3300 series are generally oil quenched, even in the low carbon grades. Steels with intermediate proportions of alloying elements and higher carbon content, for example S.A.E. 2340, are sometimes water quenched in moderately large sections. Oil quenching is also employed for small section (less than about ⅝ in. diameter or thickness) water-hardening steels. The water quenching steels come out of the bath cleaner than the oil-quenched steels.

The choice of a steel to be quenched and tempered for a given application is dependent upon the performance and properties desired. Frequently more than one commercial nickel alloy steel will meet a given set of strength, ductility and impact requirements. Selection is then dependent upon economic factors.

MAXIMUM FORGING TEMPERATURES FOR REDUCING ATMOSPHERES

S.A.E. No.	Forging Temp.,F*	S.A.E. No.	Forging Temp.,F*
2015	2220	3215	2220
2115	2220	3220	2220
2315	2220	3230	2180
2320	2220	3240	2180
2330	2200	3245	2180
2335	2200	3250	2180
2340	2200		
2345	2200	3312	2220
2350	2200	3325	2200
2515	2150	3335	2200
		3340	2200
3115	2220	3415	2180
3120	2220	3435	2180
3125	2180	3450	2180
3130	2180		
3135	2180	4340	2200
X3140	2180	X4340	2200
3140	2180	4615	2200
3145	2180	4620	2200
3150	2180	4640	2200
		4815	2200
		4820	2200

*Draw all these steels to required hardness, except as noted in the following footnote.

RECOMMENDED HEAT-TREATMENT OF S.A.E. NICKEL ALLOY STEELS*

CASE-HARDENING ALLOY STEELS

S.A.E. No.	Treatment	Normalize	Carburize, Deg. F.	Cooling Method	Reheat, Deg. F.	Cooling Method	Reheat, Deg. F.	Cooling Method	Draw, Deg. F.
2015	I	.....	1650/1700	Quench	.....	.....	.....	.....	250/300
	II	.....	1650/1700	Quench	1400/1450	Quench	.....	.....	250/300
	III	.....	1650/1700	In box	1400/1450	Quench	.....	.....	250/300
	IV	.....	1650/1700	In box	1650/1700	Quench	1400/1450	Quench	250/300
	V	.....	1500/1650(1)	Quench	.....	.....	.....	.....	If desired
2115	I	.....	1650/1700	Quench	.....	.....	.....	.....	250/300
	II	.....	1650/1700	Quench	1375/1425	Oil	.....	.....	250/300
	III	.....	1650/1700	In box	1375/1425	Oil	.....	.....	250/300
	IV	.....	1650/1700	In box	1650/1700	Oil	1375/1425	Oil	250/300
	V	.....	1650/1700(1)	Oil	.....	.....	.....	.....	If desired
2315 and 2320	I	Yes (2) to obtain the greatest accuracy and highest strength	1650/1700	Quench	1350/1400(3)	Oil	.....	.....	250/300
			1650/1700	Quench	1450/1500(4)	Oil	.....	.....	250/300
	II		1650/1700	In box	1350/1400(3)	Oil	.....	.....	250/300
			1650/1700	In box	1450/1500(4)	Oil	.....	.....	250/300
	III		1650/1700	In box	1500/1550	Oil	1350/1400	Oil	250/300
	IV		1650/1700	Quench	.....	.....	.....	.....	250/500
	V		1450/1650(1)	Oil	.....	.....	.....	.....	If desired
2515	I	Yes (2) and anneal for structure or machinability	1650/1700	In box	1325/1375(3)	Oil	.....	.....	250/400
	II		1650/1700	In box	1400/1475(4)	Oil	.....	.....	250/400
			1650/1700	In box	1500/1550	Oil	1325/1375	Oil	250/400
3115 and 3120	I	Yes (2) to reduce distortion and to improve machining	1650/1700	Quench	1400/1450(3)	Quench	.....	.....	250/300
			1650/1700	Quench	1450/1500(4)	Quench	.....	.....	250/300
	II		1650/1700	In box	1400/1450(3)	Quench	.....	.....	250/300
			1650/1700	In box	1450/1500(4)	Quench	.....	.....	250/300
	III		1650/1700	In box	1525/1575	Oil	1375/1425	Quench	250/300
	IV		1650/1700	Quench	.....	.....	.....	.....	250/500
	V		1500/1650(1)	Oil	.....	.....	.....	.....	If desired
3215 and 3220	I	Yes (2) and anneal for structure or machinability	1650/1700	Quench	1375/1425(3)	Oil	.....	.....	250/500
			1650/1700	Quench	1425/1475(4)	Oil	.....	.....	250/500
	II		1650/1700	In box	1375/1425(3)	Oil	.....	.....	250/500
			1650/1700	In box	1425/1475(4)	Oil	.....	.....	250/500
	III		1650/1700	In box	1525/1575	Oil	1375/1425	Oil	250/500
3312	I	Yes (2) and anneal for machinability	1650/1700	Quench	1375/1425	Oil	.....	.....	250/300
	II		1650/1700	In box	1375/1425(3)	Oil	.....	.....	250/300
			1650/1700	In box	1450/1500(4)	Oil	.....	.....	250/300
	III		1650/1700	In box	1525/1575	Oil	1375/1425	Oil	250/300
	IV		1650/1700	Quench	.....	.....	.....	.....	250/400
3415	I	Yes (2) and anneal for machinability	1650/1700	Quench	1375/1425(3)	Oil	.....	.....	250/300
			1650/1700	Quench	1450/1500(4)	Oil	.....	.....	250/300
	II		1650/1700	In box	1375/1425(3)	Oil	.....	.....	250/300
			1650/1700	In box	1450/1500(4)	Oil	.....	.....	250/300
	III		1650/1700	In box	1500/1550	Oil	1375/1425	Oil	250/300
	IV		1650/1700	Quench	.....	.....	.....	.....	250/400
4320 and 4615 and 4620	I	Yes (2)	1650/1700	Quench	1425/1475(3)	Oil	.....	.....	250/300
		Yes (2)	1650/1700	Quench	1475/1525(4)	Oil	.....	.....	250/300
	II	Yes (2)	1650/1700	In box	1425/1475(3)	Oil	.....	.....	250/300
		Yes (2)	1650/1700	In box	1475/1525(4)	Oil	.....	.....	250/300
	III	Yes (2)	1650/1700	In box	1525/1575	Oil	1375/1425	Oil	250/300
	IV	Yes (2)	1650/1700	Quench	.....	.....	.....	.....	250/400
4815 and 4820	I	Yes (2) and anneal for structure and machinability	1650/1700	Quench	1350/1400(3)	Oil	.....	.....	250/300
			1650/1700	Quench	1450/1500(4)	Oil	.....	.....	250/300
	II		1650/1700	In box	1350/1400(3)	Oil	.....	.....	250/300
			1650/1700	In box	1450/1500(4)	Oil	.....	.....	250/300
	III		1650/1700	In box	1550/1650	Oil	1350/1400	Oil	250/300
	IV		1650/1700	Quench	.....	.....	.....	.....	250/500

*Treatments for oil and water hardening are given on the following page.

NOTE: These instructions, recommended by the Society of Automotive Engineers, are only for guidance in selecting proper materials for different purposes, and should not be incorporated in specifications when ordering steel.

(1) In Cyanide or activated baths.

(2) Normalize at least 50 F. above carburising temperature.

(3) For case-hardness only.

(4) For core hardness.

HEAT-TREATMENT

Recommended heat-treatment of S.A.E. nickel alloy steels given in the table are based on tests and experience of steel manufacturers and users, and are intended only as a guide in selecting the proper steels and their heat-treatment. Variations in the effect of the usual forms of heat-treatment may be due to personnel, types of steel compositions or manufacture, and to changes in local conditions such as control and sensitiveness of heat-treating equipment. In order to control such variations, steels users should keep each heat of steel separate in the stockroom and during routing. Preliminary tests should precede all production operations in order that exact details of heat-treatment, particularly the normalizing, quenching and tempering temperatures, may be determined ahead for each piece of steel.

When selecting the steel, the user should keep in mind the importance of obtaining the desired strength and hardness without the necessity of resorting to drastic forms of heat-treatment. Water and brine quenching may be considered as drastic forms when applied to carbon and simple alloy steels containing more than 0.35 per cent carbon, and if improperly applied may lead to serious cracking and distortion. Frequently, drastic treatments can be avoided by control of grain size and by selecting a steel with either a slightly higher carbon content or with a little greater alloy content. Such discretion is important in the case of parts of intricate shapes and sudden changes in section.

OIL AND WATER HARDENING STEELS *

S.A.E. No.	Treatment	Normalize	Anneal	Hardening Temp. F.	Quench
2330	I	.....	.....	1450/1500	Quench
2335	II	Yes	Yes (to machine)	1450/1500	Quench
2340	I	.....	.....	1425/1475	Oil
2345	II	Yes	Yes (to machine)	1425/1475	Oil
2350	I	Yes	Yes (to machine)	1425/1475	Oil
3125	I	.....	.....	1500/1550	Quench
3130	II	1650/1750	.....	1500/1550	Quench
3135	I	.....	.....	1500/1550	Oil
3140	II	2650/1750	Yes (to machine)	1500/1550	Oil
X3140	I	.....	.....	1500/1550	Oil
	II	Yes	Yes (to machine)	1500/1550	Oil
3145	I	Yes	Yes (to machine)	1500/1550	Oil
3150					
3230	I	Yes	Yes (to machine)	1500/1550	Oil
3240	I	Yes	Yes (to machine)	1475/1525	Oil
3245	I	Yes	Yes (to machine)	1425/1475	Oil
3250					
3325	I	Yes	Yes (to machine)	1475/1525	Oil
3335	I	Yes	Yes (to machine)	1425/1475	Oil
3340					
3435	I	Yes	Yes (to machine)	1425/1475	Oil
3450	I	Yes	Yes (to machine)	1400/1450	Oil
4340	I	Yes	Yes (to machine)	1475/1525	Oil
X4340					
4640	I	Yes	Yes (to machine)	1450/1500(1)	Oil
	II	Yes	Yes (to machine)	1450/1500	Oil

* Continuation of recommended heat-treatments on page 867.

To obtain uniform physical properties make the final quench from the lowest temperature that will develop the maximum physical properties; with thinner sections, lower temperatures are used than with thick ones.

When using the lower carbon steels, simple normalizing is often sufficient to place the steel in its best condition for machining and will lessen distortion in carburizing or hardening. In the more richly alloyed nickel steels, combined normalizing and annealing constitutes best practice. For unimportant parts, the normalizing may be omitted entirely or annealing practiced only when the steel is otherwise difficult to machine.

The process of carburizing refers to the various dry or pack-hardening methods, as well as to the newer processes utilizing gases and molten baths as the carburizing media. The procedure after pack-hardening is usually divided into two methods: (1) quench direct, and (2) cool slowly or in box. The first method refers to the removal of the work from the furnace or from the carburizing box and quenching the parts while they are at or slightly below the carburizing temperature. The second method is to allow the work to cool slowly without quenching, in the box or container, or in a cooling chamber provided in the furnace. Parts carburized in activated baths should be treated similarly to other carburized work and may be given any of the hardening treatments shown in the table under the specific steel.

Suggested Tempering Temperatures to Obtain High Yield Strength in Sections up to 1½ in.

S.A.E. No.	Yield Strength, lb. per sq. in. 100,000	125,000	150,000	175,000	200,000	225,000
	Tempering temperatures, F.					
2315	675	700**	...	...	...	...
2330	925	800	700	600	450**	...
2340	1,125	975	850	750	650	500
2350	...	1,050	900	800	700	575
2515	950	700	525**	...	...	...
3115	800	800**	500**	...	...	...
3130	1,025	850	725	625**	...	...
3140	1,125	950	825	725	575	...
3150	1,200	1,125	900	800	650	475
3240	1,225	1,075	950	800	650	475
3250	.....	1,125	975	850	700	500
3312	1,050	875	700	...	...	...
3330	1,200	1,025	875	750	575	...
3340	.....	1,125	975	825	700	575
3415	1,100	900	700	...	...	...
3435	1,200	1,025	850	725	600	...
3450	.....	1,075	900	775	650	550

** Water hardened steel.

CHARACTERISTICS AND APPLICATIONS OF S.A.E. NICKEL ALLOY STEELS

CARBURIZING STEELS

S.A.E. No.	CHARACTERISTICS	APPLICATIONS
2015 and 2115	Hardens readily from oil quench with minimum distortion	Differential gears Locomotive valve motion parts
2515	Wear and fatigue resistance in case High core strength Freedom from scaling and distortion Low quenching temperatures Good machining properties	Automotive wrist pins, king pins, transmission gears, ring gears and pinions, steering arm balls; aircraft engine cams; rock-drill parts; machinery parts for heavy-duty service; heat-exchanger tubes; chain pins; machinery gears
2315 and 2320	Resistance to grain growth High surface hardness by oil quenching; low quenching temperatures minimizes scaling and distortion	Automotive piston pins, gears, spline shafts, steering gear parts, knuckle pins; pump shafts; tubing for low temperatures; machinery cutters, skips, cages and track pins; hydraulic valves and fittings; machine tool gears and spindles
3115 and 3120	Machines readily Refined case and core with double treatment after carburization Hard wear-resistant surface Tough core, shock resisting	Used where requirements do not demand high alloy steels; piston pins; differential and transmission gears; oil-well bit and reamer cutters; machine tool gears; small case-hardened parts when carbon steels are not satisfactory; tool arbors; collets
3312	Has wear and fatigue resistant case High core strength Air hardening tendencies Not as readily machined as other steels	Heavy-duty service parts such as roller bearings for railroad equipment; truck and bus gears; engine cams; pistons, knuckle pins, differential gears and pinions; machinery swivels and bearings; broaches
4815	Hard wear-resistant cases Excellent machining properties Can be hardened with minimum distortion Tough and shock resisting	Heavy-duty service parts, including truck, bus, tractor and passenger car transmission gears; bearing rollers; rock-drill cutters
4615	File-hard case on oil quenching High core strength with single oil quench Outstanding machining properties Highly resistant to wear	Cups, cones and rollers in small roller bearings; automobile steering gear parts, wrist and piston pins, differential gears and splined shafts; rock drills; spindles; slush-pump liners; tractor and machinery gears; tool arbors; broaches; collets

OIL AND WATER HARDENING

2300	Low critical cooling rates Low temperature quenching with resultant decrease in scaling and distortion Good elastic properties and strength without loss in ductility or impact resistance Excellent torsional and fatigue properties	S.A.E. 2330 — Highly stressed bolts and nuts; tubing subjected to torsion and fatigue; parts from cold-drawn stock requiring strength, ductility, good machining properties, and accuracy in machining S.A.E. 2335 and 2340 — Connecting rods, drive shafts, bar stock and forgings S.A.E. 2345 and 2350 — Gears, axles, shafting
3100	Creep resistance at high temperatures Good elastic and wear properties Have deep hardening properties Easily forged and heat-treated	Those with 0.30% carbon used for axles; shafts; stressed bolts, nuts. Annealed and cold-pressed car frames S.A.E. 3130 and 3140 — Engine intake valves; flanges and fittings for high-temperature service; crankshafts; well drilling tools; machine tool gears; wear-resistant parts of machinery
3200	Better physical properties than 3100 steels of comparable carbon content Excellent deep hardening properties Great strength combined with ductility	Automobile drive and axle shafts; side bars in link chains; transmission gears; master connecting rods in radial aircraft engines; highly stressed bolts, pins, keys and shafts; tool holders; propeller shafts
3300	Excellent physical properties Have air hardening properties Require reduced cutting speeds and feeds High fatigue resistance High strength combined with ductility	For forgings and bars required to meet rigid mechanical and physical properties, especially in aircraft engines. Connecting rods, rocker arms, magneto and oil-pump gears, propellor hub cones, accessory drive shaft and starter gears
3400	Excellent fatigue resistance High strength combined with ductility Same hardening properties as 3300 steels	Used in heat-treated forgings for machine parts. S.A.E. 3450 for heavy-duty gears of medium section in machine tools
4600	Have spring properties when oil hardened and tempered to 440 Brinell At low tempering temperatures, develops high hardness and strength, good ductility, and high impact resistance High wear resistance when dipped or heated in cyanide prior to quenching When grain size is controlled, they have uniform physical properties and excellent machining characteristics	S.A.E. 4640 and 4650 are the only ones applied to any extent commercially in small sections. Used in springs and heavy-duty rollers in railroad roller bearings. Also, automotive overdrive units, piston pins, differential gears, gears and pinions, shackle bolts, steering gear parts, transmission gears, spline shafts, countershafts, and universal joints. Bearing cups and cones (outer and inner races); chain pins; machine tool gears, tool holders; slush-pump liners; pneumatic tool chucks; arbors; boring bars; chisels; collets

MACHINING THE NICKEL STEELS

Nickel steels are tougher than straight carbon steels, and their hardness will vary according to heat-treatment. In turning them in the annealed or normalized state with high-speed steel tools, surface speeds usually run from 35 to 85 ft. per min. for light cuts, the higher speeds being used for fine feeds. With heavy cuts, surface speeds will run from 15 to 30 ft. per min. Single-point tools in general use have side-rake angles of 16-20 deg., back-rake angles from 3 to 5 deg., side cutting edge angles of 10 deg. and end and side relief angles, usually from 3 to 6 deg.

In machining these steels with cemented carbide tools, chip curlers or breakers should be ground on the tools if the cut is continuous, in order to break up the chips or coil them into convenient form for removal at high cutting speeds. Using these cutting tools for fine feeds and light cuts, on annealed or normalized steels, surface speeds as high as 600 ft. per min. can be used under suitable conditions.

Back rake on cemented-carbide tools vary from 6 to 15 deg., while side rake angles vary from 8 to 30 deg. The relief angles all around the cutting edge usually run from 6 to 12 deg. For ordinary work, the end cutting edge angle is usually 15 deg. while the side cutting-edge angle varies from 5 to 20 deg. For interrupted cuts on lathes or planers, it is desirable to use a tool with a negative back rake as great as 8 deg. in combination with 10 deg. or more side rake.

The hardness of the steel has a marked bearing on the cutting speed. For example, steels with a Brinell hardness of 250 may be cut with cemented-carbide tools at surface speeds as high as 300-400 ft. per min., while with steels of 680 Brinell the cutting speeds must be reduced to 20-30 surface ft. per min.

Surface finish on heat-treated nickel steels, machined with cemented-carbide tools at high speeds, is in many cases turned with sufficient precision that subsequent grinding is not necessary. In other cases, grinding allowances have been reduced, saving wheel wear.

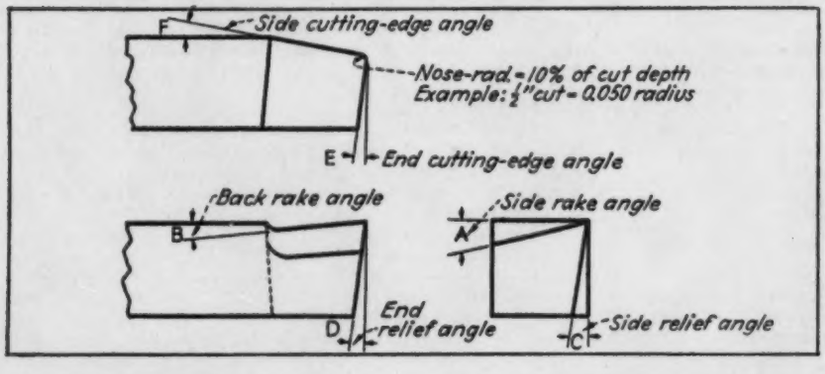
Milling of nickel steels, especially in the harder state, is done with cemented-carbide tipped-face mills. Stagger-tooth cutters, with special angles, frequently permit table feeds six to twelve times those possible with high-speed steel mills. The surfaces produced are often accurate and smooth enough to dispense with subsequent grinding.

Form tooling of the S.A.E. steels of low-carbon content, annealed dead soft, is not satisfactorily done with cemented-carbide tools. Stellite and high-speed steel tools cut these steels at economical speeds. At high hardnesses, above 250 Brinell, steel-cutting carbide form tools have worked very well. The reason is that dead soft stock permits telescoping the chips and cuts in a "gummy" manner, while heat-treated high-hardness nickel steels cut smoothly with cemented-carbide tools above 250 ft. per min.

Most of the S.A.E. steels are prepared in the form of bars for use in hand and automatic screw machines. For this work, the cutting speeds are higher than those just mentioned, because lighter cuts are generally used.

For accuracy of dimensions, freedom from rolling mill scale, and improvement in machinability, cold drawing is practiced widely. Usually the hot-rolled bars are not equal in machinability to the cold-drawn product; however, those steels which harden excessively in cold drawing are often machined in the hot-rolled annealed condition. There are available tables which give the machinability rating of steels based on the rating of S.A.E. 1112 as 100 per cent; these speeds are suggested only for set-up purposes and must be modified to meet the requirements of the particular operation and cutting fluid.

HIGH-SPEED STEEL SINGLE-POINT TOOLS FOR MACHINING S.A.E. NICKEL STEELS



Steel	Angles, Deg. A	B	C	D	E	F
Group 1....	20	5	6	3	10	10
Group 2....	18	5	6	3	10	10
Group 3....	16	3	6	3	10	10

Group 1—S.A.E. 2015, 2115, 2315, 4615 and 4620.

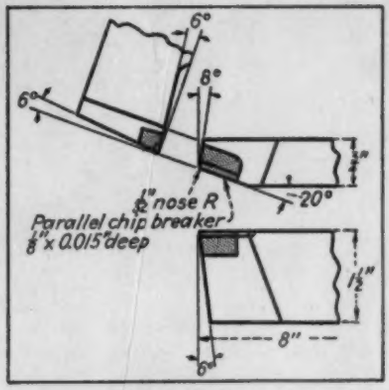
Group 2—S.A.E. 2320, 2330, 2335, 2515, 4340, X4340, 4815, 4820.

Group 3—S.A.E. 2340, 2345, 2350, 3115 to 3450, inclusive, and 4640.

NOTE: Tools made of 18-4-1 highspeed steel, hardened to Rockwell 63C. It has been found that a flood of coolant gives longer life between grinds.

EFFECT OF COLD-DRAWING NICKEL ALLOY STEELS

S.A.E. No.	Size stock, in.	Condition	Strength, lb. sq. in. Yield	Ultimate	Elong. 2 in., %	Red. area, %	Brinell
2315	1 1/4 Rd.	Hot-rolled	55,200	76,100	31.2	65.3	153
	1 1/4 Rd.	Cold-drawn	77,800	86,600	16.5	61.0	192
2330	1 1/4 Hex.	Hot-rolled	61,300	101,000	22.5	50.0	196
	1 1/4 Hex.	Cold-drawn	120,000	125,000	11.5	43.0	228
3140	1 1/4 Rd.	Annealed	49,700	87,300	30.0	65.0	173
	1 1/4 Rd.	Cold-drawn	104,000	108,000	17.0	58.0	217
3240	1 1/2 Rd.	Annealed	57,300	89,900	29.0	69.3	170
	1 1/2 Rd.	Cold-drawn	102,000	107,300	18.5	64.8	207
3435	1 1/4 Rd.	Annealed	60,500	98,900	27.0	58.5	193
	1 1/4 Rd.	Cold-drawn	108,000	117,900	16.0	51.9	241
4615	1 1/4 Rd.	Hot-rolled	61,900	82,300	27.0	67.0	183
	1 1/4 Rd.	Cold-drawn	103,000	108,300	15.0	58.0	223



This turning tool tipped with cemented carbide has a parallel chip breaker which produces a long continuous chip when machining nickel steels

CUTTING OILS FOR NICKEL STEELS

Operation	Group 1*	Group 2**
Grinding	50W + 1SO(F)	50W + 1SO(F)
Cold sawing, high speed	30W + 1SO	20W + 1SO
Cold sawing, low speed	SM(3)	SM(3)
	LM	LM
Hobbing, milling and drilling	15W + 1SO	10W + 1SO
	SM(3)	SM(2)
	LM	.....
Turning, boring, planing and shaping	20W + 1SO	20W + 1SO
	SM(4)	SM(2)
	LM	.....
Reaming	10W + 1SO	10W + 1SO
	SM(3)	SM(1)
	LM	.....
Broaching (roughing) under 1-in	15W + 1SO	10W + 1SO
	SM(4)	SM(3)
	LM	.....
Broaching (roughing) over 1-in	15W + 1SO	10W + 1SO
	SM(3)	SM(2)
	LM	.....
Broaching (finishing) under 1-in	SM(2)	SM(2)
Broaching (finishing) over 1-in	SM(2)	SM(1)
Broaching (finishing) heavy duty	SM(1)	SM(1)
Die threading and tapping	SM(2)	SM(1)
	SM(3)	.....
Pipe threading and automatic tapping	SM(1)	SM(1)

* S.A.E. steels 2015, 2315, 2320, 2330, 2335, 2515.
** S.A.E. steels 2340, 2350; 3115, 3120, 3130, 3140, 3150; 3220, 3230, 3240, 3250; 3312, 3325, 3340; 3415, 3435, 3450; 4320, 4340, 4620, 4640, 4820.
Legend:
W = water.
SO = soluble cutting oil.
SO(F) = soluble cutting oil processed to free itself of grits and dirt.
SM = sulphurised mineral oil; numbers in parentheses indicate cutting strength, number (4) being the strongest.
LM = straight mineral oil.
30 W ± 1SO = 30 parts water plus 1 part soluble cutting oil.

BROACHING

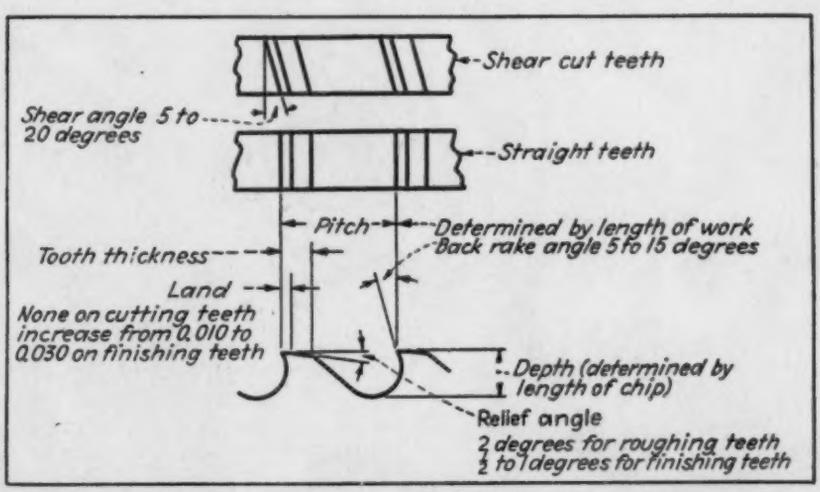
Broaches can be designed for the S.A.E. nickel alloy steels providing the latter have been properly forged, annealed or normalized to produce correct machinability. Research on forged parts designed for broaching has shown that it is necessary to maintain a forging temperature higher than that usually used and one that must remain uniform within 100 F. Machinability for broaching is improved by repeated hammering or compressing the metal during forging.

The dies must be properly designed so that no flash is created that restricts the compressing of the metal in subsequent operations; also, the flash must be longitudinal with the heading tool or there must be a flash pocket to prevent the metal from flowing between the dies so that the compression is not restricted by the flash material.

When these steels are properly forged, annealed, or normalized to produce correct machinability, they may be broached with the same broaches used for other alloy steels, but with some changes in broaching speeds and feeds, and type of coolant. The cut per tool can remain the same, but by lowering the broaching speeds on the tougher material, finish will be improved, sizes can be maintained and broach life will be increased. The average cut per tooth is determined by the strength of the broach and the shape of the part to be broached.

For internal broaching of spline holes, where broaches have sufficient strength, a cut per tooth of 0.004 to 0.005 in. on the diameter, is recommended. On surface broaching, the cuts vary from 0.0025 to 0.0035 per tooth depending on the length, shape and size of the part.

A coolant is more beneficial during the broaching operation than a lubricant. Cutting oils have a tendency to hold heat and, due to the friction caused by broaching, the broach or broaches become overheated, causing expansion and increased sizes. However, this condition will not occur if a sufficiently large volume of soluble oil is used.


Shear cut teeth
Shear angle 5 to 20 degrees
Straight teeth
Pitch
Determined by length of work
Back rake angle 5 to 15 degrees
Tooth thickness
Land
None on cutting teeth
increase from 0.010 to 0.030 on finishing teeth
Depth (determined by length of chip)
Relief angle
2 degrees for roughing teeth
1 to 1 degrees for finishing teeth

Nickel steels are difficult to broach, but when they are forged and heat-treated properly, this tooth design is used successfully at reduced broaching speeds

DRILLING

In drilling S.A.E. nickel alloy steels, the Brinell hardness can be considered as a measure of their machinability. For hardnesses up to 200, regular high-speed drills, operated at peripheral speeds of 65-90 ft. per min., are satisfactory. Point angles of 118 deg., and lip clearance angles of about 10 deg. are recommended. For steels having Brinell hardnesses around 250, better results are obtained with drills having points of 130-140 deg., and lesser tip clearance angles, as low as 5 deg. in some cases.

For a hardness of 300 Brinell, a peripheral speed of 40 ft. per min. and drills with a point angle of 130

CUTTING SPEEDS AND FEEDS FOR S.A.E. NICKEL ALLOY STEELS USING DIFFERENT TYPES OF TOOLS †

Steel	Depth of cut, in.	High-Speed Steel				Stellite J-Metal**				Cemented Carbides††	
		Feeds, in. per Revolution									
		1/64	1/32	1/16	1/32	1/64	1/32	1/16	3/32	1/16	1/32
		Surface Speed, ft. per min.									
Group 1	1/32	86–93	74–80	60–65	52–56	132–142	113–122	98–106	86–93	337–364	307–332
	1/16	79–85	69–74	58–62	49–53	120–130	105–113	91– 98	80–86	319–345	283–306
	1/8	70–76	61–66	53–57	44–48	108–117	95–102	81– 88	72–78	295–319	258–279
	1/4	58–62	52–56	44–48	37–40	91– 98	80– 86	68– 73	59–64	270–292	228–247
	1/2	41–44	37–40	34–36	27–29	66– 72	59– 64	50– 54	43–46	194–210	185–200
Group 2	1/32	73–82	63–70	51–57	44–49	112–125	96–108	84– 94	73–82	288–320	262–292
	1/16	67–75	59–65	49–55	42–47	103–115	89–100	78– 87	68–76	273–304	241–269
	1/8	60–67	52–58	45–50	38–42	92–103	81– 90	69– 77	62–69	252–281	220–246
	1/4	49–55	44–49	38–42	32–35	78– 86	68– 76	58– 64	50–56	231–257	195–217
	1/2	35–39	31–35	28–32	23–26	57– 63	50– 56	43– 48	37–41	166–185	157–175
Group 3	1/32	64–70	55–60	45–49	38–42	97–107	84– 92	73– 80	64–70	248–274	238–250
	1/16	58–64	51–56	43–47	36–40	89– 98	77– 85	67– 74	59–65	236–260	210–230
	1/8	52–57	45–50	39–43	33–36	80– 88	70– 77	60– 66	54–59	218–240	191–210
	1/4	43–47	38–42	33–36	27–30	67– 74	59– 65	50– 55	44–48	200–220	169–186
	1/2	30–33	27–30	25–27	20–22	49– 54	44– 48	37– 41	32–35	144–158	137–150
Group 4	1/32	53–60	45–51	37–42	32–36	80– 91	69– 78	60– 68	53–60	206–233	188–213
	1/16	48–54	42–48	35–40	30–34	74– 83	64– 72	56– 63	49–55	195–221	172–196
	1/8	43–48	38–42	32–37	27–31	66– 75	58– 65	50– 56	44–50	180–204	157–179
	1/4	35–40	32–36	27–31	23–25	56– 63	49– 55	42– 47	36–41	165–187	140–158
	1/2	25–28	23–25	20–23	17–19	41– 46	36– 41	31– 35	26–30	119–134	112–128

Group 1 — High speeds are for S.A.E. 2015, 2115; intermediate speeds for S.A.E. 3115, 3120, 3130*, 4815, 4820; low speeds for S.A.E. 2330*, 2335*, 3135*.

Group 2 — High speeds are for S.A.E. 2315, 2320, 3140*, X3140, 4615, 4620; intermediate speeds for X3140*, 3145*, 3215, 3220, 3230*, 3415; low speeds for S.A.E. 3150*, 3312, 4150*, 3430*, X4340*, 4640*.

Group 3 — High speeds are for S.A.E. 2340*, 3125, 3130, 3230, 3240*, X4340*, 4640; intermediate speeds are for S.A.E. 2330, 3135; low speeds for 2335, 2345*, 2515, 3140, 3150*.

Group 4 — High speeds are for S.A.E. 2340, 2350*, X3140, 3150, 3240*, 3245*, 3250*, 3325, 3335*, 3340*, 3445*, 3450*; low speeds for S.A.E. 3240, 3245, 3250, 3335, 3340, 3435, 3450.

* Annealed steels.

** With Stellite "2400", these speeds can be increased 25–30 per cent.

† Data are for continuous cutting with lubricant.

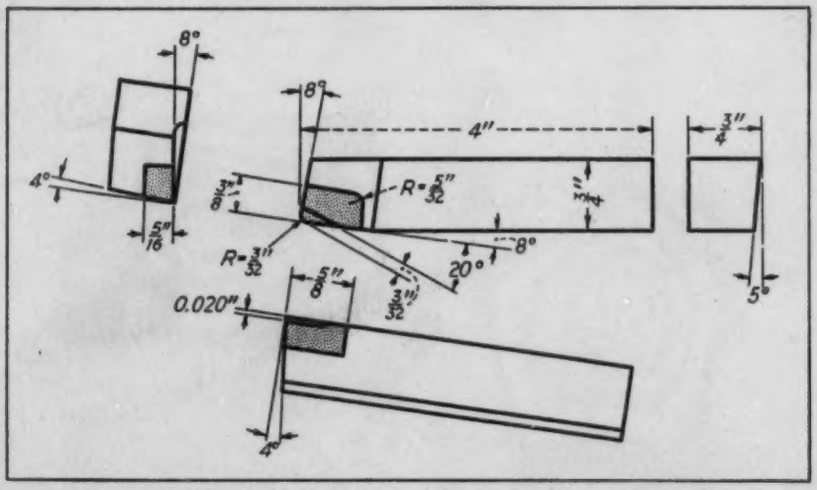
†† For feeds other than those given here, the following speeds are recommended: S.A.E. 2015–2320, 150–350 ft. per min. for 1/4 to 5/16 in. cut and 1/64 in. feed; 60–100 ft. per min. for 5/16 to 3/4 in. cut and 1/32–1/16 in. feeds. S.A.E. 2330–4820 inclusive, 150–300 ft. per min. for 1/4 to 5/16 in. cut and 1/64 in. feed; 40–80 ft. per min. for 5/16 to 3/4 in. cut and 1/32–1/16 in. feeds.

NOTES: For continuous cuts without lubricant, decrease cutting speeds 25 per cent.
For intermittent cuts with lubricant, decrease cutting speeds 15 per cent.
For intermittent cuts without lubricant, decrease cuttings speeds 40 per cent.
For light finishing cuts and fine feeds, cutting speeds can be increased from 50 to 100 per cent.

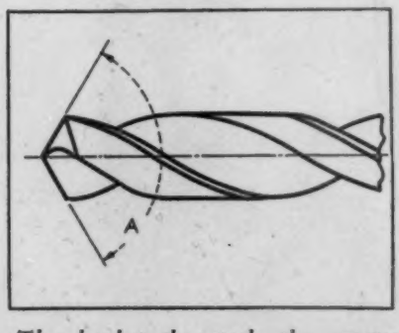
deg. is recommended. For steels with a Brinell hardness around 350, drills with a point angle of 130-150 deg., operating at 20 ft. per min., are recommended. When Brinell hardness runs 400 and higher, the drills should be ground with a 150 deg. point angle, and run at a peripheral speed of 15 ft. per min.; they should have a heavy web structure, thinned at the point and designed with a slower helix angle. For steels of 350-400 Brinell hardness, cobalt and other types of proprietary drills are preferred to the regular type of high-speed drills.

Where the depth of the hole is equal to four or five times the diameter of the drill or more, oil-hole drills should be taken into consideration. This applies to drills 3/8 in. and larger.

In drilling these steels, soluble oil, sulphurized oil, and in some cases a high grade mineral oil are favored as a cutting fluid, as shown in the table on cutting fluids.



One design of box turning tool that is used on turret lathes has a chip breaker form ground



The harder the steel, the greater should be the point angle when drilling. For steels with Brinell hardnesses up to 250, the point angle A should be 118 deg. For Brinnell hardness of 300, 350, 400 and above, use point angles of 130, 130–150 and 150 deg., respectively

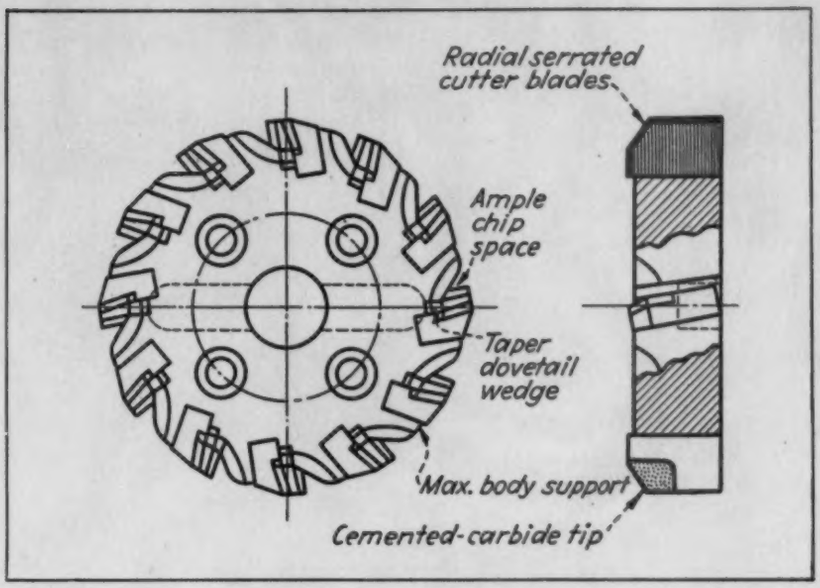
Recommended Drilling Feeds and Speeds for S.A.E. Nickel Steels, Using High-Speed Drills

Size, In.	Drilling Feeds, Inches per Revolution, in Steels of Following Brinell 170–200	240–300	350–400
⅛	0.0040	0.0025	0.0015
¼	0.0070	0.0050	0.0025 †
½	0.0100	0.0075	0.0040 †
¾	0.0130	0.0100	0.0060 †
1	0.0160	0.0120	0.0075

Drilling Speeds in S.A.E. Nickel Steels:

S.A.E. No.	Brinell No.	Drill Speed, Peripheral Ft. Per Min.
2015	170–200	110*
2115	170–200	85–90*
2315–2515	170–200	65**
3115–3150	170–200	70–85**
4340–4820	170–200	60**
All	240–255	50**
All	300	40**
All	350†	20**
All	400†	15**

* With soluble oil cutting lubricant.
** With sulphur base cutting lubricant.
† Cobalt high-speed, or similar, drills are recommended.



Stagger-tooth cutters tipped with cement carbide permit high milling speeds on nickel steels of high hardness. This illustration shows the radial rake and negative back rake used in obtaining a shearing action with these mills

TAPPING AND THREADING

Only high-speed or better graded taps are recommended for tapping the S.A.E. nickel alloy steels. Those containing molybdenum are tapped better when the cutting face of the tap has up to a 10-15 deg. rake, while those for tapping nickel-chrome steel give better results with a hook up to 10-15 deg. Recommended peripheral speeds for high-speed taps in the nickel alloy steels are 20-35 ft. per min., with the lower cutting speeds advisable for tapping nickel-chrome and nickel - chrome - molybdenum steels. However, these speeds can be increased by at least 5 ft. per min., when taps are made of material tougher than high-speed steels.

When threading S.A.E. nickel alloy steels, the chamfer or lead angle should be at least 20 deg. The feed of a threading tool is fixed by its pitch; thus, one with a pitch of 16 threads per inch must feed 0.0625 in. per revolution. Hence, a long chamfer on chasers is the only way to distribute the cut unless the thread is recut; this should be taken into consideration when the piece to be threaded is first laid out on the drawing board.

These steels, because of their alloying elements, should not be threaded at a surface speed much over half of that of regular screw stock—the higher the carbon, the lower the threading speed. The cutting edge of dies should be relatively smooth and ground with an ample hook of say 15 deg. Chasers should, for economic reasons, be reground frequently to remove false edges and to maintain proper clearances and keen edges. Frequent resharpening means less tool costs and better work.

The nature of these steels makes it desirable to have good alignment of the die and work. The die head should be given a proper and sufficient start in order to prevent cramping, tearing and taper threads. The chasers should be relatively hard, and where the stock is heat-treated before threading, the chasers should be ordered to specifications that specify the hardness of the stock.

In general, the following threading speeds have been found satisfactory

Threading Speeds for S.A.E. Nickel Steels

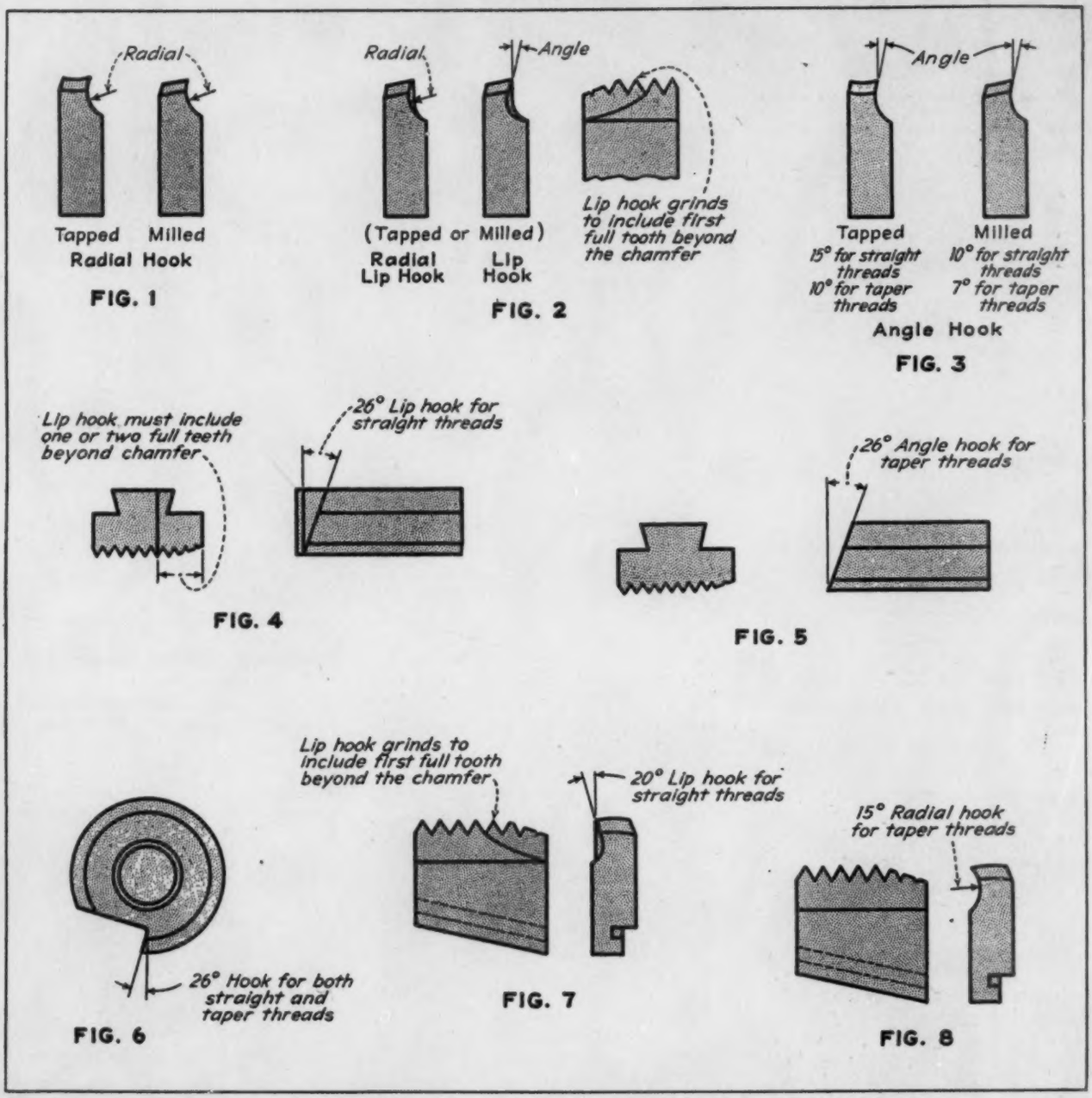
Thread diam., in.	Course thread (U.S.S.) Surface speed ft. per min.	Speed, r.p.m.	Fine thread (S.A.E.) Surface speed ft. per min.	Speed, r.p.m.
¼	35	535	40	611
⅜	30	306	35	357
½	25	191	35	286
⅝	25	153	35	214
¾	20	102	30	153
1	20	76	30	115
1¼	18	55	25	76
1½	18	46	25	64
2	15	29	20	38
2½	15	23	15	23
3	10	13	19	15

NOTE: These cutting speeds are for annealed stock only. When heat-treated material is threaded, decrease the cutting speeds 20 to 30 per cent.

TYPICAL SPEEDS AND FEEDS USING STELLITE J-METAL

S.A.E. No.	Part	Operation	Depth of cut, in.	Speed, ft. per min.	Feed, in. per rev.
2315	Pinion gears	Rough turn	1/16	60	0.032
3120	Ring gears	Rough turn O.D. and face both sides	1/16	160	0.020
3120	Ring gears	Semi-finish turn O.D. and face both sides	1/16	255	0.023
3135	Gear blanks	Turn	1/16	100	0.033
3140	Ring gears	R. turn and face both sides	1/16	210	0.016
3140	Auto. valves	Rough and finish turn O.D., seat and top face	1/32	140	0.016
4615	Rear-axle ring gears	Rough and finish turn, face, bore and chamfer	1/16–1/8	177–200	0.019

NOTE: Coolant used for all operations.



Cutting face grinds on chasers for threading S.A.E. nickel alloy steels. In some cases the radial hook, Fig. 1, or the lip hook, Fig. 2, will produce better results than an angle hook. Fig. 3—Milled and tapped chasers for die heads. Figs. 4 and 5—Tangent type chasers for die heads. Fig. 6—Circular chasers for die heads. Figs. 7 and 8—Collapsing tap chasers

for these nickel alloy steels: for a pitch of 3-7½ threads per in., 8 ft. per min.; for 8-15 pitch, 10 ft. per min.; for 16-24 pitch, 15 ft. per min.; and for pitches of 20 threads per in. and above, 20 ft. per min. These speeds are subject to change, depending upon the cutting qualities of the material, lubricant used, and the condition of the machine and threading equipment.

Due to the low sulphur content of these steels, a good grade of sulphurized oil should be a part of the cutting lubricant. However, mineral lard oil, containing about 20 per cent lard oil has also been found satisfactory.

MILLING

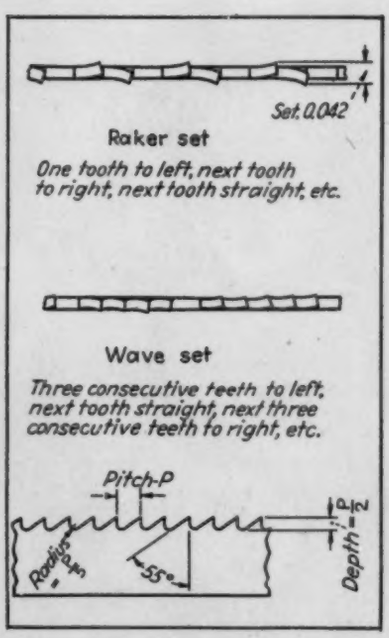
The most effective cutting speeds and feeds in milling are governed by the structure and hardness of the part, the amount of metal to be removed, the type of cutting tool, and nature of the cutting fluid. In general, cutting speed is selected to give the best compromise between maximum production and maximum life of the cutter. For the S.A.E. nickel steels cutting speeds of 60-70 surface ft. per min., and feeds of 0.008-0.010 in. per tooth, are commonly used. The finish cutting speeds are often 40 to 80 per cent higher than roughing speeds.

Recommended teeth angles are as follows: End relief angle, 3-5 deg.; clearance angle, 10-15 deg.; rake angle, 10-15 deg. The land usually is $\frac{1}{32}$ or $\frac{1}{16}$ in. wide. The clearance behind the cutting edge must be sufficient to avoid rubbing, but should not be so great as to allow the cutter to "hog in."

SAWING

Band Saws—In cutting nickel alloy steels over ¼ in. thick, a hard temper saw with 8-14 teeth per inch, and with a raker set (one tooth to the left, one tooth straight, and one tooth to the right, etc.) gives a smooth finish and a satisfactory saw life. Recommended cutting speeds for S.A.E. nickel, nickel-chromium and nickel-chromium-molybdenum steels are 250, 200 and 175 ft. per min., respectively. Thickness of material determines to a large extent the proper pitch of the saw; in general, saws for cutting thick sections should be of a coarser pitch than those for cutting thin ones.

For cutting materials ¼ in. thick and under, an 18 to 32 pitch wave-set saw, operating between 400 and 1,500 ft. per min. should be used; the higher speeds being recommended for the thinner materials. A wave-set saw is one with three consecutive teeth to the left, the next tooth straight, and the following three consecutive teeth to the right, etc. In all cases, the greater the feed, the wider and heavier must be the saw to withstand the cutting pressures. The steels are cut without a coolant of any kind, the heat generated being dissipated as the band travels around the carrier wheels.


Set 0.042
Raker set
One tooth to left, next tooth to right, next tooth straight, etc.
Wave set
Three consecutive teeth to left, next tooth straight, next three consecutive teeth to right, etc.
Pitch-P
Radius
55°
Depth = P/2

Raker-set band saws with 8-14 teeth per inch operating at 250, 200 and 175 ft. per min., are recommended for nickel, nickel-chromium and nickel-chromium-molybdenum steels, respectively, over ¼ in. thick. For material under ¼ in. thick, wave-set saws of 18-32 pitch, running at 400–1,500 ft. per min. are suggested

SUGGESTED WHEELS FOR GRINDING NICKEL ALLOY STEELS

Operation	Abrasive type	Abrasive Grit Size	Abrasive Grade	Bond	Wheel speed, Surface Ft. Per Min.
Annealed Steels:					
Centerless	Alum. ox.	30–60	Hard or med.	Vitrified	5500– 6500
Cylindrical	Alum. ox.	36–60	Med.	Vitrified	5500– 6500
Cutting-off	Alum. ox.	30–46	Hard or med.	Resinoid	10000–16000
Internal	Alum. ox.	40–60	Med. or soft	Vitrified	5500– 6500
Surface:					
Straight	Alum. ox.	24–50	Med. or soft	Vitrified	4500– 5000
Cylinder	Alum. ox.	24–40	Soft	Vitrified	4500– 5000
Case-hardened steels:					
Centerless	Alum. ox.	40–80	Med.	Vitrified	5500– 6500
Cylindrical	Alum. ox.	40–80	Med.	Vitrified	5500– 6500
Cutting-off	Alum. ox.	46–50	Hard or med.	Resinoid	10000–16000
Internal	Alum. ox.	40–60	Med. or soft	Vitrified	5500– 6500
Surface:					
Straight	Alum. ox.	24–50	Soft	Vitrified	4500– 5000
Cylinder	Alum. ox.	24–40	Soft	Vitrified	4500– 5000
Tempered Steels:					
Centerless	Alum. ox.	50–80	Med. or soft	Vitrified	5500– 6500
Cylindrical	Alum. ox.	50–80	Med. or soft	Vitrified	5500– 6500
Cutting-off	Alum. ox.	46–50	Hard or med.	Resinoid	10000–16000
Internal	Alum. ox.	46–80	Med. or soft	Vitrified	5500– 6500
Surface:					
Straight	Alum. ox.	24–50	Soft	Vitrified	4500– 5000
Cylinder	Alum. ox.	24–40	Soft	Vitrified	4500– 5000

NOTE: For mirror finishes, silicon-carbide shellac-bonded wheels of soft 320 grit abrasive, and silicon-carbide resinoid-bonded wheels of very soft 500 grit abrasive, have been recommended.

Solid-Tooth Circular Saws—To this group belong saws from 8 to 32 in. diameter used for cutting metal cold. They are usually operated on milling machines and ordinary saw benches, in the smaller diameters, and on metal cutting-off machines in the larger diameters. In general, the saw speed should not exceed 60 ft. per min. There are some cases where speeds can be increased to 90 ft. per min. or more, while there are others where it is advantageous to hold the speed to 50 ft. per min. or less. Teeth angles for these circular saws will vary from 8 to 15 deg. for hook or rake angle, and from 7 to 12 deg. for the top clearance angle. Recommended feeds range from $\frac{1}{32}$ in. to 2½ in. per min. for general-purpose work.

Inserted-tooth Saws—An inserted-tooth saw is not recommended for diameters under 18 in. They do not provide smooth cutting, because of the large tooth space required. For cutting S.A.E. nickel alloy steels, rim speeds up to 40 ft. per min. and feeds from 2½ to 10 min. per min., are recommended. Hook angles for the inserted teeth vary from 10 to 15 deg., while top clearance angles vary from 5 to 12 deg.

Hacksaws—For cutting the steels in question, hacksaws can be operated up to 100 strokes per min., with speeds varying from 0.008 to 0.020 in. per stroke, depending upon the size of blade being used. Feed pressures recommended vary between 75 and 250 lb.

GRINDING

In so far as the selection of grinding wheels is concerned for S.A.E. nickel alloy steels, the plain nickel, nickel chromium, and nickel-chromium-molybdenum steels can be considered in the same general classification. They can be ground with the grinding wheels given in one of the accompanying tables.

These specifications might have to be modified depending on special requirements of any given job. If extra fine finishes are required, it might be necessary to resort to a finer grit and softer grade of grinding wheel. For example, one grinding wheel manufacturer recommends for a mirror finish a soft-grade shellac-bonded wheel using 320 grit, or a very soft resinoid-bond wheel using 500 grit.

In machine grinding, work speed exerts a pronounced effect on the performance of grinding wheels. In general, fast work speed tends to wear the wheel faster than slow work speed. The higher the work speed in relation to the wheel speed, the more work the wheel is required to do in a given amount of time; hence, the wheel has a tendency to wear at a faster rate. Should the work speed be decreased without changing the wheel speed, the wheel will be required to do less work in a given time, and will have a tendency to wear more slowly. Also the longer or larger the arc of contact between the wheel and the work, the faster should be the speed of the work for the wheel to cut steel properly.

WELDING NICKEL ALLOY STEELS

S.A.E. nickel alloy steels may be arc welded by a procedure not greatly different from that used for any general-purpose electrode. Plain nickel and nickel-chromium steels, of the 2,000 and 3,000 series are weldable, but care must be used where the carbon runs above 0.25 per cent. Plain nickel steels with carbon contents over 0.25 require preheating at 300–600 F.

Nickel-chromium steels cannot be safely welded without preheating. For the lower tensile ranges having a maximum of 0.20 per cent carbon a preheat of from 200–300 F. is all that is necessary, but with the higher carbon contents that accompany the increased percentages of nickel and chromium a 600–800 F. preheat is desirable, followed by slow cooling. For the highest carbon, nickel and chromium contents raise the preheat temperature to 900–1,100 F. Keep the work at the preheat temperatures until it is placed in annealing furnaces; stress relieving should be done at annealing temperatures of 1,200 F.

Nickel-molybdenum and nickel-chromium-molybdenum steels in the S.A.E. 4,000 series have been successfully welded in some instances, using a heavily coated shielded arc electrode in a downhand position on parts preheated to 400–600 F. and stress relieved at 1,200 F.

Electrodes higher in tensile strength than the general-purpose electrodes for welding low-alloy high-tensile steels, containing under 0.30 per cent carbon, are recommended for welding the high-alloy nickel steels. The electrodes may be used in all positions, although downhand welding is recommended wherever possible; $\frac{5}{16}$-in. electrodes are used for vertical welds in heavy sections, while $\frac{5}{32}$- or $\frac{1}{8}$-in. electrodes are recommended generally for vertical or overhead welding, especially in thinner sections. The electrode should be positive (work negative). Each bead should be thoroughly and carefully cleaned before following beads are applied.

For flat welding, a 30-volt arc is recommended for most types of electrodes held not less than $\frac{1}{8}$ in. from the end of the coating to the work; the coating must not contact the molten metal. The arc voltage for vertical and overhead welding should be 25 volts minimum. In vertical welding, a shelf is built up at the bottom, and a full weave from side to side is used as the welding progresses from the bottom. In overhead welding, the electrode which is held vertical is moved slightly back and forth.

In gas welding nickel alloy steels, the nickel has little effect on the flowing of the metal as it is melted; actually, the fluidity is increased and there is a reduction in sparking. The strength of the weld is increased by nickel melted into the welds from the base metal. Parts being welded should be preheated at 300–600 F. to prevent cracking as the weld metal passes through the hot-short range.

The S.A.E. nickel-chromium alloy steels can be welded by the oxy-acetylene process, but they have properties which cannot be completely duplicated after welding, even by heat-treatment. These steels should also be preheated before welding, at temperatures ranging from 300–600 F., and stress relieved at temperatures above 1,100 F.

Molybdenum in steels, ranging from 0.15 to 0.40 per cent has little if any effect on the flowing of the steel as it is melted. Actually, molybdenum makes the steel more suitable for welding in that its presence retards grain growth and resists embrittlement in steels subjected to high temperatures. Preheat and stress relieving temperatures used with nickel and nickel-chromium steels also apply to those containing molybdenum.

GAS CUTTING

The simple progressive type of gas cutting, with the preheating flame surrounding the cutting oxygen orifice, can be used on the S.A.E. nickel-alloy steels. Those with carbon contents of 0.25 per cent or less may be cut safely without preheating. However, preheating or reheating may be necessary when carbon runs high, or cutting is done below 60–80 F., to prevent damaging the cut surface and to preserve or restore commercial properties. This is applicable to S.A.E. 2015, 2115, 2315, 2330, 3115, 4615.

The remaining S.A.E. nickel-alloy steels harden under the gas flame and should be heat-treated, furnace or otherwise, subsequent to cutting to improve or recondition the structure of the cut surface. It is important to keep the material warm between the time of cutting and heat-treatment.

Current Variations for Welding Nickel Steels

Electrode size, in.	Current Ranges	
	Down*	Vertical and Overhead**
$\frac{1}{8}$	75–130	75–130
$\frac{5}{32}$	90–175	100–160
$\frac{3}{16}$	140–225	125–180
$\frac{1}{4}$	190–325	.....
$\frac{5}{16}$	250–400	.....

* Minimum arc voltage = 30 volts.
** Minimum arc voltage = 25 volts.

WELDABILITY OF NICKEL STEELS

S.A.E. Series	Carbon, %	Nickel, %	Chrome, %	Molybdenum, %	Type of Welding: Metal Arc	Carbon Arc	Gas	Spot	Seam	Butt or Flash	Preheat Temp., F
2000	0.25 max	3. 5 max	.....	.....	x	x	x	x	x	x	None*
	0.25–0.50	3. 5 max	.....	.....	x	n	x	o	o	o	300–600†
3000**	0.20 max	1. 0–2.0	0.40–0.80	.....	x	n	x	o	o	o	200–300
	0.20–0.30	1. 0–3.5	0.40–1.50	.....	x	n	x	o	o	o	600–800
	0.35–0.55	1. 0–3.5	0.40–1.75	.....	x	n	x	o	o	o	900–1100
4000††	0.15–0.45	1. 5–2.0	0.30–0.90	0.20–0.40	x	n	n	o	o	o	400–900
	0.10–0.45	1.65–2.0	.....	0.20–0.30	x	n	n	o	o	o	400–900
	0.10–0.25	3.25–3.75	.....	0.20–0.30	x	n	n	o	o	o	400–900

The letter x indicates that the process may be used under the conditions stated.
The letter n indicates that no data are available on which to base a recommendation.
The letter o indicates that the process is not used.
NOTE: If heat-treated prior to welding, these data do not apply.

NOTE: As a rule, preheat temperatures should be maintained until parts are stress relieved usually at an annealing temperature of 1,200 F.
* Preheating to 200–300 F. or higher may be desirable to prevent distortion or cracks due to shrinkage during cooling.
** Nickel-chromium steels with more than 0.25 per cent carbon have properties which cannot be duplicated after welding, even by heat-treatment. These steels cannot be welded safely unless preheated; slow cooling is desirable.

† Air hardening and require slow cooling.
†† Very little data available, S.A.E. 4340 welded for aircraft structural assemblies.

Profits—Not Profiteering

"YOUR industrial friends probably will make a killing now, what with lots of war business and with prices going up." Such was the salutation of an acquaintance outside business circles the other day.

And it is something to stop and think about. At a time when industry has become a political goat and is blamed for most everything, what is more natural than to have talk about "war profiteering" and unjustifiably higher prices crop up?

That is why a solemn obligation rests upon manufacturers today to be moderate in their actions and to lean over backwards not to take undue advantage of the situation.

Many industrialists who have been searching for the past decade for the horn of plenty have suddenly found it. Once again the well-worn law of supply and demand is at work full blast, with demand exceeding supply with a vengeance.

In a seller's market, anyone will admit it is a temptation to charge what the traffic will bear. But already industrial leaders with vision to see ahead the disastrous consequences of such a policy have put on the brakes. They have laid down the sound rule that industry must not profit unreasonably from war. And prices must not be blindly raised in the present emergency—there must be a real justifiable reason.

Speaking for the Warner & Swasey Company, Charles J. Stilwell, president, says, "We have no intention whatever of exploiting this demand pricewise. . . . All machines to be shipped up to and including January of next year will be at present prices, and . . . any price readjustments necessary after that date will reflect increased costs only."

J. F. Lincoln, president of the Lincoln Electric Company, has put his company on record in opposition to exploiting the present emergency. He states publicly, "We pledge ourselves, as far as possible, to maintain present prices. If the materials we buy are increased in price, or the cost of labor is increased, then we pledge ourselves to raise selling prices no more than the bare increase in cost of raw materials and labor going into our products."

Significantly Mr. Lincoln adds, "We pledge ourselves to pass on to our customers the reduction in cost made possible by better manufacturing methods, wider distribution and technical advances in production."

A spokesman for the National Association of Manufacturers calls upon all members "to exercise vigilance against any price or profit policies not justified by actual cost and anticipated cost of replacement."

Industrial management generally should take heed of the amber light ahead and go slow. Every manufacturer is entitled to a fair profit and obviously increases in manufacturing costs inevitably necessitate increases in selling prices, but those few who attempt to charge what the traffic will bear will sooner or later run afoul of public opinion. Good public relations, not to mention good old-fashioned horse sense, call for sane and sensible pricing policies.

Burnham Finney

GAGING BUSINESS

All-time high in production reached by many branches of metal-working industry. Considerable amount of business placed by firms manufacturing peace-time products.

An all-time high has been reached in production in many branches of the metal-working industry. Getting business is no longer a worry. The main problem is how to make deliveries within a reasonable time. Most companies are operating two or three shifts, with more manufacturers each day going onto a 24-hour-a-day basis. Though war and national defense requirements admittedly are responsible for a large share of current activities, a great amount has originated in industries making peace products.

MACHINE TOOLS—Bookings from domestic customers have been heavy. Almost without exception machine tool builders are giving U. S. users preferential treatment, some companies having turned down large foreign orders as a result. Wright Aeronautical and Pratt & Whitney Aircraft have been the biggest machine tool buyers. The volume of business completely divorced from war materials, however, has been surprisingly good. One of the country's largest dealers reports orders at the highest level since 1929, with practically all sales being made to a wide variety of firms outside the aircraft or munitions fields. French and British orders have been pouring into machine tool builders. Orders and inquiries from Russia and Japan have been unusually brisk. The delivery situation is rapidly becoming worse as the industry fails to make any headway against its unprecedented backlog of orders.

AIRCRAFT — Wright Aeronautical and Pratt & Whitney Aircraft are preparing for major expansion of their aircraft engine production. Their expenditures for plant additions and new equipment will run into the millions. This program will necessitate enlargement of factory facilities by engine parts suppliers. Allison Engineering Co. will start manufacture in its new aircraft engine plant at Indianapolis about November 1. Airplane makers are working three shifts. Glenn L. Martin alone has a backlog of orders estimated at $66,439,616.

STEEL—Steel output is hovering around 90 per cent, the highest on record, and will continue close to the current rate the remainder of the year. Unexpectedly heavy tonnage from railroads and abnormal releases from automobile makers have tightened the market more than expected.

SHIPBUILDING—Almost all yards which can be pressed into service are going top speed. Aside from the Navy's billion-dollar building program, the Maritime Commission has 141 cargo vessels in various stages of construction or under contract. Recent awards to Puget Sound yards have raised the total work on the Pacific Coast to $50,000,000. The Canadian government will shortly order 30 ships to cost $1,250,000 each from Canadian yards.

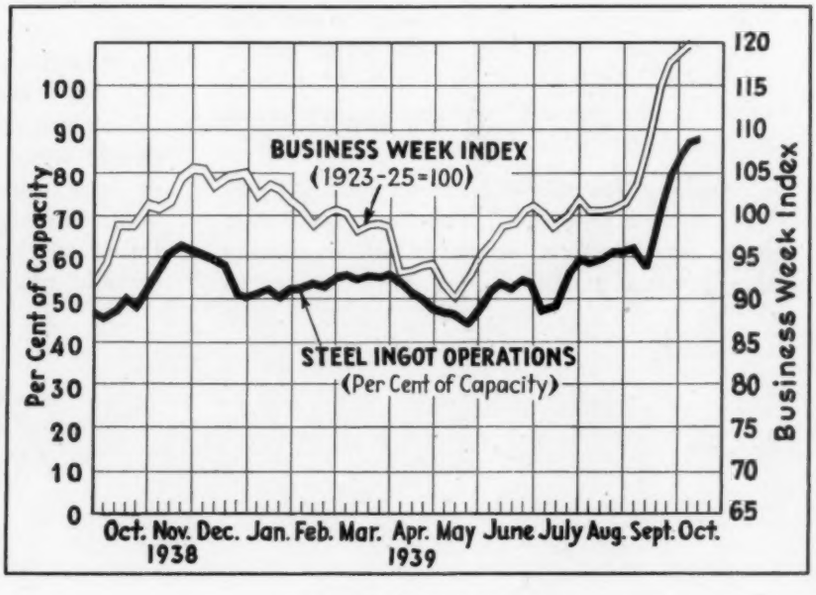
MUNITIONS—Winchester Repeating arms Co. will supply the U. S. Army with 67,000 Garand rifles at a cost of $8,710,000. This production order is in addition to an earlier educational order for the same item. Bethlehem Steel and Scovill Mfg. Co. have been awarded army contracts for ammunition parts amounting to $2,667,924 and $302,937 respectively. The War Department has also placed sizable orders recently for explosives, guns, pistols and sighting systems. One company is reported tooling up to make torpedoes for the French government in case the embargo is lifted. American Car & Foundry will furnish tanks costing $6,000,000 to the Army.

FARM IMPLEMENTS — Stocking dealers with new tractor models has aided output. International Harvester, for example, has gone to a five-day week at its Chicago works for that purpose. Light tractor sales have been good enough to more than offset the disappointing season in combines. So far, total farm implement and tractor sales this year are comfortably ahead of last year. If the war continues, manufacturers are in for a boom. On the other hand, should peace come soon, the outlook for spring business is somewhat dubious.

RAILROAD EQUIPMENT — Extraordinary purchases of rolling stock and motive power continue. Santa Fe is spending $10,000,000 for equipment, including 2,800 freight cars. Northwestern is buying two streamlined trains, Great Northern 1,500 ore cars and Northern Pacific 3,000 more box cars.

STEEL PRODUCTION VS. GENERAL BUSINESS

Up to a near capacity figure soars steel production under the impetus of war buying and purchases by those wishing to escape inevitable price rises. Accelerated tempo of business activity also continues



NEWS OF THE INDUSTRY

CANADA EXPECTS HEAVY BUYING FROM BRITAINS MUNITIONS AND SHIPS COMPRISE MAJOR ITEMS

OTTAWA—Huge British war contracts have not yet been placed in Canada because the British government hasn't yet decided what it wants most from this country. However, some orders for steel, shells and armament parts, have been received by cable by companies, such as National Steel Car and Dominion Steel which already are handling contracts. Subchasers also have been bought by the British here.

Construction of ships is expected to take a considerable part of the $100,000,000 the Canadian government will spend before the end of the current fiscal year on March 31 on war supplies. An initial order for 30 ships to cost about $1,250,000 each is anticipated soon. This work probably will be divided among four well-equipped yards—Canadian Vickers, Canada Steamship's Davie yard, Dominion Steel's Halifax yard and St. John dry dock. Most other Canadian shipyards would have to be refitted for construction work on ships.

Talk is current here that $600,000,000 of munitions order will be awarded to Canadian firms in the next two weeks. Most of the money would be spent for shells and ammunitions. Companies receiving contracts would be free to buy their own equipment.

Machine Tool Builders Express Opposition to United States Being Involved in European War

Prosperity and Strength of Country Based on Well-Equipped Industries

CLEVELAND — Strong sentiment against the United States becoming involved in the current European war was expressed at the thirty-eighth annual convention of the National Machine Tool Builders' Association at the Hotel Cleveland October 2-3.

Though the meeting was held at a time when the industry is swamped with the biggest orders in history, attendance was heavy. In addition to two open sessions, the program consisted of a closed session and the usual series of group meetings.

The convention unanimously adopted a resolution declaring itself "opposed to warfare and in favor of the maintenance of honorable peace in the United States." The resolution expressed the conviction that "real wealth is created only by the production of those goods and services which add to the possessions and the welfare of all the people," and that war is destructive of these benefits.

"Any prosperity stimulated by war is a false prosperity, and must be

TO PLACE EDUCATIONAL ORDERS; NEW WARTIME CONTRACTS READY

WASHINGTON—Forty-six items on the educational orders program of the War Department will be issued for bids within the next two weeks and contracts totaling $8,800,000 will soon be let, according to Brigadier-General C. T. Harris, Jr., assistant to the Chief of Ordnance, U. S. Army, speaking at a roundtable session at the annual meeting of the Army Ordnance Association.

Sample copies of the new wartime contracts are now available to manufacturers who wish to study their provisions, said General Harris. Arrangements have been made in wartime for the War Department to place contracts on a negotiated basis rather than to the lowest bidder as required by law in peacetime. Some of the risks heretofore imposed on the manufacturer in wartime contracts are reported to have been eliminated from the new contracts.

New Officers of the National Machine Tool Builders Association

President
JOHN E. LOVELY
Vice-President Jones & Lamson Machine Co.

First Vice-President
FREDERICK V. GEIER
President Cincinnati Milling Machine Co.

Second Vice-President
CLIFFORD S. STILWELL
Executive Vice-President Warner & Swasey Co.

Treasurer
WENDELL E. WHIPP
President Monarch Machine Tool Co.

New N.M.T.B.A. Directors

H. B. KRAUT
President Giddings & Lewis Machine Tool Co.

E. C. BULLARD
Vice-President and General Manager Bullard Co.

paid for a thousand times over by the loss in life, in resources and in business activity throughout the world, which inevitably follows war," asserted Wendell E. Whipp, retiring president of the association, in his address "Charting a New Course."

Warns of War Business Dangers

Mr. Whipp pointed out the pitfalls in taking war-time foreign business and remarked that "the destinies of the machine tool industry are interwoven with the destinies of America's domestic manufacturing enterprises. Our great, lasting and permanent market lies in this country." He said that "the industries of this country have had, so to speak, a psychological kick in the pants which has knocked them off the do-nothing, venture-nothing, buy-nothing seat which they have so long occupied. . . . Let us interpret the present business uplift not as a war boom, but as a release of the hitherto demmed-up productive energies of this country."

Mr. Whipp urged the industry to continue research, invention and improvement of its products through the present period so that when the war is over and British and continental machine tool companies again can compete seriously in world markets, American tools will be substantially better than competitive foreign makes. He also counseled the industry "not to lose sight of the importance of maintaining a vigorous and effective sales department against the inevitable aftermath (of war)."

Can Keep Out of War

The United States can keep out of the war "if we have the intelligence and will to do so," said W. T. Holliday, president Standard Oil Co. of Ohio, in an address on "Industry and War." "Only in the remote and incredible contingency of an attack upon American shores would we be confronted with any real necessity of going to war . . . In spite of our sympathies and emotions we should recognize that the greatest service we can give to democracy is to make sure, by keeping our country out of the war, that there shall be, whenever peace comes, at least one strong democracy left in this world."

Berna Urges Cooperation

In his report as general manager of the association, Tell Berna expressed the belief that "the prosperity of our nation, in peace as in war, must be based on well-equipped industries." He outlined developments in wages and hours laws as they apply to the machine tool industry and discussed terms of payment for foreign orders which will safeguard builders against losses.

He said that cooperation with the federal government in matters of defense is an obligation upon every machine tool builder. He urged the officers in charge of buying machine tools for the government to abandon, so far as they legally can, unnecessary complications that sometimes find their way into government specifications, such as preliminary inspection of parts before assembly in addition to inspection of the finished machine, expensive demonstrating service on small simple machines, and long-drawn-out production tests.

Colonel E. E. MacMorland, procurement planning division of the War Department, Washington, described what the machine tool industry can do to help national defense. W. P. Kirk, sales manager Pratt & Whitney Division Niles-Bement-Pond Co., speaking on "The Sales Department Can Help," pointed out that the salesman is the most important link between the company and its customer. Salesmen should be trained to be ethical and should be sellers of new machines, not traders of old machines. One job of the salesman is to keep the customer modernization-conscious.

Foreign Developments Outlined

Many interesting observations on foreign countries were made by speakers who recently had returned from abroad. George A. Bryant, Jr., executive vice-president Austin Co., commented on the shortage of skilled help in all European countries and on the fact that it takes many more men in Soviet plants than in American factories to produce the same article. A. M. Johnson, Sundstrand Machine Tool Co., said that German and Italian factories prefer U. S. machine tools but cannot buy them, and that Swedish auto factories are equipped with large numbers of used American machine tools.

Machine operators in Japanese metal-working plants range from young girls to old men, said Howard W. Dunbar, vice-president Norton Co. Hours of work range from eight to ten per day. Compensation for a first-class mechanic in Tokyo is about ten yen a day, but elsewhere it is only 3-3½ yen. There is a tendency toward incentive payment systems, and apprentice training is carried on extensively. In one Japanese automobile plant are approximately 1200 U. S. machine tools and 800 German-made machines.

German Auto Discussed

H. B. Kraut, president Giddings & Lewis Machine Tool Co., told association members that the German government has been paying 40 per cent cash and 60 per cent in tax anticipation certificates for goods purchased from German firms. Mr. Kraut described how orders are being taken by the German government for the Volkswagon, new small automobile, at a cost of 990 marks. Down payment is 55 marks, the customer then paying five marks a week. The money collected thus far is going toward building the plant in which these cars are to be made. The government has a total of 660,000 orders. The original schedule called for production of 500,000 cars in 1940 and 1,000,000 in 1941.

At a closed session Charles J. Stilwell, president Warner & Swasey Co., made a report for the committee on cooperation with government departments and Walter W. Tangeman, vice-president Cincinnati Milling Machine Co., reported for the show committee. In explanation of the postponement of the Machine Tool Show, Mr. Whipp said that with the flood of domestic orders, nobody could afford to take time out for a show.

INSIDE DETROIT

By Rupert Le Grand
DETROIT EDITOR

Slowdown strikes threaten last-quarter operations, which are seen as 37 per cent ahead of last year. Additional shifts considered necessary to meet extra demand.

DETROIT — Implications of the UAW-CIO demands upon the Chrysler Corp. are such that a long-drawn-out, costly battle is seen. The union assault, led by Richard T. Frankensteen, is based on issues upon which the company can not afford to yield. In brief, the company has been asked to relinquish its authority in respect to hiring and firing, to the right to discipline unruly workers, and to set standards of production.

Unlike earlier forays, union leaders have apparently left no loophole in their demands that would permit a face-saving retreat. The supposition is that they are willing to gamble everything in a fight for power. This scrap may prove a union high-water mark.

On the other hand, company officials are convinced that a reputation has been built up for paying good wages and treating labor fairly. Under these or any circumstances they can see no reason for surrendering vital functions of management to Mr. Frankensteen. Even though the strike drags out for weeks, and the production loss amounts to 100,000 cars, it is believed that the corporation will not give up its right to run the plants.

The union's effort to subdue Chrysler is costing terrific sums. If all 55,000 hourly workers go out, their daily loss in wages will amount to $418,000, figured at an average of 95 cents per hour for an eight-hour day. The company stands to lose $2,925,000 per day, representing the wholesale value of a daily production of 4,500 vehicles worth on an average $650 each. Thus, a complete shutdown for several weeks could easily cost labor and company $100,000,000 in wages and sales. But the issues at stake may make such a loss unavoidable. It can not be recouped later.

Additional Shifts

Chevrolet's assembly schedule of 260,000 cars and trucks during the last quarter will not be upped, despite the upsurge in domestic sales. The present rate of production is at better than a million-car year, which if attained for the 1940 model will exceed the approximate 1939 total of 750,000 cars and trucks by 33 per cent. Production is soon to attain 5,000 units per day, but it is doubted that peak output of 6,000 per day will be reached before the spring bulge in sales. A third shift in assembly plants is not considered necessary this fall.

Ford expects to build more than a quarter of a million Ford and Mercury cars before the first of the year. This represents a 44 per cent increase for the Sept.-Dec. period, as compared with last year. Starting with the November schedule, the daily rate will be 4,000 units.

There has been talk that Buick will go to a third assembly shift in order to keep pace with the current demand, which exceeds anything encountered previously in the company's history. Some departments are working now on a three-shift basis and output runs currently at 1250 units per day. Company sources say that there is a possibility that a third assembly shift may be required.

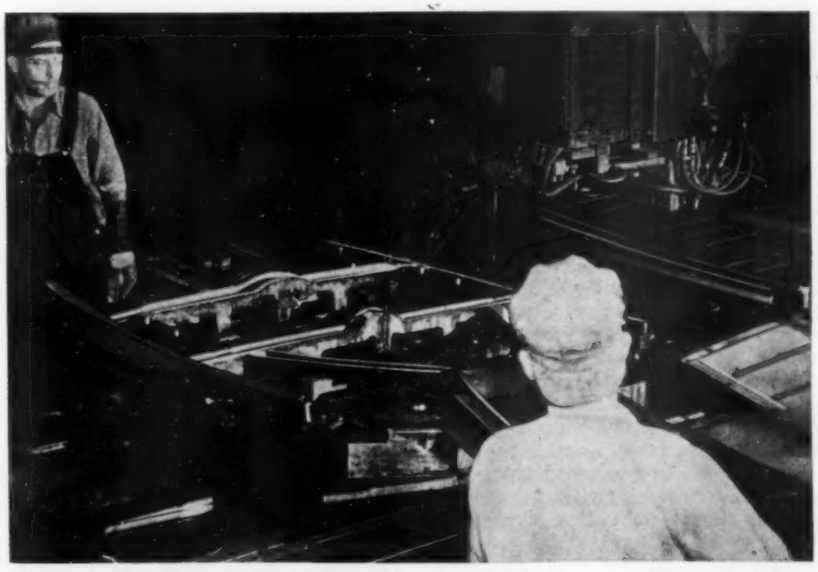
Nash is bogged down again with labor trouble that threatens to have an ill effect on the entire sales season, just as it did last year. Several days were lost during September and the plants were shut down for the first weeks in October. The men are holding out principally for a written contract, the company being willing to grant pay increases. Nash sales in September were 100 per cent ahead of last year, and unfilled orders are higher than since 1929. Eleven thousand cars had been built by Oct. 1, but that volume may not place enough cars in dealers' hands to hold customers. Another shift may be added when the strike ends.

Hydra-Matic transmissions, an optional feature on Oldsmobile, are expected to commence flowing out of the Detroit Transmission Division this week at the rate of 500 per day. It is understood that a considerable saving was made by changing from a fully machined master valve to a die-cast construction.

PRODUCTION TO SURPASS 1937

DETROIT — Automobile and truck production is rapidly nearing a stabilized level of approximately 100,000 units per week. Independent manufacturers expect capacity operations during the last quarter (*AM*—Vol. 83, page 830e), and major producers see no reason why their earlier ambitious projections should not hold good.

With October calculated to account for 345,000 units, and November and December adding 850,000, the fourth quarter output should be in the neighborhood of 1,200,000 cars and trucks. This amounts to an increase of 37 per cent as compared to the Oct.-Dec. 1938 period. Output in the last quarter should also surpass the fourth quarters of 1937 and 1936 by a wide margin.



Channel-Section Body Frame—*Reinforcements provided in the 1940 Chevrolet bodies built by Fisher take the form of an actual channel-section steel frame. Assembled separately, the frame is fused to the ribbed steel flooring and becomes an integral part of the box-section members at the sides*

Hydraulic Drive—*To obtain exceptionally smooth surfaces on the crankcase of its new type sealed unit air conditioning compressor Westinghouse uses a planer with hydraulic drive. The V-16 compressor will be driven by a 100-hp. motor built as an integral part of the machine and cooled by refrigeration*

Apprentice Training Programs Rushed as Danger of Skilled Labor Shortage Grows

WASHINGTON—Many industrialists are thinking in terms of insuring themselves an adequate reservoir of skilled labor. At the same time the War Department is scratching its head over a possible shortage of good machinists in case of war. Hence numerous metal-working companies, as long-range insurance, are looking into possibilities of improved and expanded apprentice training programs.

Always worried about the capacity of the essential metal-working industry to meet wartime conditions, the Army has been shocked by European experience. In Britain serious bottlenecks developed in the first month of the war because of shortages of skilled machinists and tool designers. Even in technical-minded Germany reliable reports indicate a dearth of machinists when the war broke out.

In its studies of industrial mobilization, the War Department fears that in wartime there will not be enough highly skilled machinists to go round, especially with the Army drawing off considerable numbers to service its own equipment. In a few sectors of industry, it is found, employment needs in wartime of some types of skills would more than quadruple. A report to be published soon will reveal a serious situation in aircraft.

First result of this line of thought is that the Federal Committee on Apprentice Training has instructed its field staff to spend all its time starting new training programs in the defense industries—which is to say the metal-working industry. This committee is a permanent agency of the Department of Labor. It has drawn up detailed educational and personnel standards for apprentice training programs in various crafts, on the basis of which it administers apprentice exemptions in the Walsh-Healey and wage-hour acts.

Major part of its activities, however, are devoted to promotion of apprentice training among individual employers. Upon invitation members of its field staff of fifteen go into plants and guide initiation of training programs, while a Washington office functions as a clearing house for information and suggestions. Budget for this year is $175,000.

Hitherto the committee has concentrated on the construction of crafts because its small staff made it desirable to work in one industry, and the construction people were eager for help. But recently there has been a shift in emphasis and approved training plans are now functioning at Lockheed and Boeing Aircraft, while plans are in process of organization at Pratt & Whitney, Curtiss-Wright, and North American.

Pressure on Congress is likely soon to increase FCAT's appropriation as a defense measure. And if the Army and Navy munitions board should decide to accompany some of its educational orders with recommendations as to the value of apprentice training, it would doubtless stimulate industry's cooperation in the program.

Apprentice training is not actually a preparedness measure, since it would normally be about four years before results would show. A shortage in wartime would be met by dilution of skilled workers with semi-skilled and by introduction of automatic processes. But recent surveys have focused attention on the extent to which the reservoir of craft skill has been depleted the past ten years. Many machinists who rode out the depression driving a taxi or swinging a WPA shovel have not retained much of their skill. And some of the former resources of replenishment have been closed. Whereas in earlier years about 50,000 skilled workers normally came to this country from abroad each year, during the last decade the flow has been reversed. In 1932 more than 10,000 left.

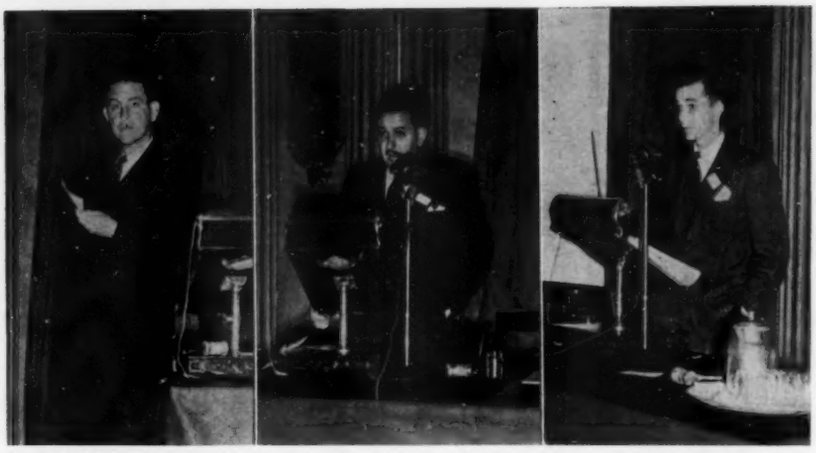
Too Few Training Programs

Many training programs too were dropped and never entirely replaced. A 1937 study by the National Industrial Conference Board showed that only 55 per cent of metal-working plants had active apprentice training programs. The total number of apprentices was about 7 per cent of the skilled labor force. Since apprenticeship lasts four years and normally a 50 per cent mortality occurs, this is not nearly enough to meet the 5 per cent attrition rate usually needed for the skilled labor force.

Organized labor does not oppose apprentice training. The American Federation of Labor has long been in favor of it, and the International Association of Machinists flatly states that it is 100 per cent behind the work of the Federal Committee on Apprentice Training. IAM feels, as does the committee, that the program does not so much involve a net addition to the number of men entering the machinist trade as an attempt to insure that those men who do be adequately trained. Journeymen machinists are required to undergo an apprenticeship; the union has always regarded it as part of its job to see that apprentices have an opportunity to learn; and it thinks of the present program as helping the work.

The union moreover is well satisfied with FCAT's insistence on protection of apprentices through written contracts and on representation on the groups administering the training programs in each plant.

Even when the Army speaks of a war reserve of skilled labor and envisages a peacetime situation in which many men doing semi-skilled work would have the training to do the skilled jobs such as tooling, the machnists' union is not unduly disturbed. The alternative is widespread substitution of specialized single-purpose machines with unskilled operators for the work of the all-round machinist—and this is what the machinists are most afraid of.



Harold W. Adams, Douglas Aircraft Co., left, analyzed manufacturing problems caused by the adoption of high-pressure hydraulic control systems. W. A. Hite, Vultee Aircraft, center, told of recent developments in the industry, while H. C. Hill, Wright Aeronautical Corp., right, discussed difficulties in the quantity production of aircraft engines caused by frequent design changes

Automotive Engineers Focus Attention on Emergency Aircraft Production Problems

LOS ANGELES—The Fourth Annual S.A.E. National Aircraft Production Meeting held here October 5, 6, and 7 threw a searching spotlight on the problems and possibilities of emergency production of aircraft and aircraft engines, accessories and parts, in the light of present world military conditions. Brigadier General Jacob E. Fickel, Air Corps GHQ Air Force, in reporting on progress of the President's Air Expansion Program, quoted Roosevelt's speech to Congress last Jan. 12, in which he said, "Military aviation is increasing today at an unprecedented and alarming rate." Reviewing progress in expenditure of $300,000,000 for expansion of the Army Air Corps, intended to provide the air service with 5,500 airplanes by June 30, 1941, Gen. Fickel outlined in detail the steps that have been taken to secure necessary aircraft production without undue expansion of the existing industry.

Staged in conjunction with the sessions was an exhibit of aircraft parts and accessories which drew the interest of industry engineers and production men with displays of latest parts, materials, accessories and equipment. Included were extensive exhibits of metals by Aluminum Industries, Inc., Aluminum Co. of America and International Nickel Co. Numerous examples of modern aircraft machine work were on display by Aircraft Precision Products, Inc.; United Aircraft Products, Inc.; Aircraft Accessories Corp. and others.

Outstanding talks were presented on detailed machine methods used in various phases of aircraft production. Arvid Nelson, Hamilton Standard Propellers, gave an illustrated lecture outlining step by step all the machine processes developed in the manufacture of modern metal propellers with their automatic constant speed control mechanisms. He told how machine process had been applied to propeller making almost entirely to eliminate hand work. Close-up moving pictures were shown to illustrate blade milling operations; vertical shaping of hub slots, which had reduced previous milling time; routing internal cams of the control mechanism; turret lathe work where a keyed color system assured use of the right tool in the right holder; and many other machine operations.

Problems in connection with the manufacture of high-pressure hydraulic systems were discussed by Harold W. Adams, Douglas Aircraft Company. He indicated that high-pressure hydraulic systems refer to those operating at pressures above 2,000 lb. per sq. in. While machine work must be more accurate for these more highly stressed parts, Mr. Adams pointed out that the heavier wall thicknesses required make it easier to hold close tolerances. Thus machine costs are no greater for the high-pressure system than for the conventional hydraulic systems.

An informative discussion on quantity production of aircraft engines was presented by H. C. Hill, Wright Aeronautical Corp. One of the peculiar problems of aircraft engine production emphasized by Hill is the high ratio of design changes to units produced. This runs, on the average, close to two changes for each three engines, and so complicates the shop problem of standardizing on parts in process to get runs in economical numbers. The speaker also pointed out that engine reliability had been improved through developing a forged steel crankcase machined all over, as compared with the forged aluminum alloy case previously used. While the steel case was heavier at first, and cost more to machine, intensive development work brought both the weight and cost down to the level of the material previously used, while the life and reliability of the engine were materially improved.

Rapidly increasing application of magnesium alloys in cast, forged, sheet and extruded form to aircraft work was outlined in a paper by L. B. Grant of the Dow Chemical Co. Mr. Grant stressed the claim that magnesium alloys are the easiest of all common metals to machine, and that proper precautions completely eliminate the fire hazard. His hearers were convinced that this metal will be used more widely in future aircraft work. Discussion from the floor brought out the fact that Europe is well in advance of the United States in the development and use of magnesium alloys.

Arvid Nelson, of Hamilton Standard Propellers, outlined detailed steps in machining metal propellers and their control mechanisms

Closing paper of the meeting dealt with aluminum, being presented by G. D. Welty, Aluminum Co. of America, together with moving pictures of the mining and refining of aluminum. The pictures also showed in great detail the manufacture of aluminum sheet, tube, extrusions, etc.

Other papers presented during the meeting dealt with more general production problems, such as interchangeability, accelerated production in emergencies, experimental engineering, submerged engine installation problems, and development of the in-line type aircraft engine.

Approximately 875 persons registered and additional visitors were believed to have raised the total attendance to more than 1,500.

WATCHING WASHINGTON

McGraw-Hill Washington Bureau

PAUL WOOTON, CHIEF

Though battle over neutrality act still rages, agreement should be reached early in November. Administration keeps mum on questions of labor peace and wartime profiteering.

WASHINGTON—Hardly anybody is neutral about neutrality. The public and Congress are divided on repeal of the embargo, but nearly all want to see Hitler soundly drubbed—only they want a couple of other fellows to do it. Congress seems to have gone over to the President by a substantial margin. This became evident when interest in the Senate debate dropped off. The House passed a bill last session and so will not debate the proposal; will enter the joint conference committee after Senate action. Best guesses place signing of the act sometime in early November.

Labor Peace—At a Price

There's more behind lack of progress toward peace between CIO and AFL than appears on the surface. Peace will come at a price. Both organizations are in deadly fear of regimentation, minus a great deal of their privileges under the Wagner Act, if general industrial and labor mobilization comes. The Administration has not peeped about labor control, but it's one of the most important problems that would have to be met, and it's loaded. Will labor be controlled vertically by industries, or horizontally by fiat? In either case, both contending groups want a seat at the conference that measures their cut in the profits of expansion. When they make peace, there will be stipulations on this point.

Winchester Gets Garand Contract

Winchester was awarded a War Department contract for 65,000 thirty-caliber semi-automatic Garand rifles at a cost of $8,710,000. This award is made under the $110,000,000 rearmament appropriation voted by Congress last session. You will recall that Winchester got one of the original six educational orders, which was for 500 of these rifles at a cost of $1,300,000, which amount was largely spent for jig, dies, fixtures. The big new order is a follow-up of the educational order. Objective is to equip 400,000 regulars and national guardsmen with this weapon, which has five times the power of the old Springfield.

Prevent Profiteering?

Industry's chief problem due to the war in Europe is still control of prices and profiteering. The President has left the choice of self control or federal control up to industry by assurance that no legislation is contemplated at this time. Business representatives here say that if industry can avoid price inflation and exploitation of Europe's misfortune, federal legislation can be put off indefinitely. One of the darkest threats against industry's success is the human tendency to shun individual responsibility. One of the brightest hopes is the Commerce Department's proposal to spread accurate knowledge of inventories.

Still More Shipbuilding

Maritime Commission's building program is under forced draft with 141 cargo vessels under contract. If the European war keeps going there will be urgent demand for expansion of yards and ways. Already a number of applications for money to expand building capacity have gone to RFC. Added to the speedup of construction for foreign service under the subsidy, there is increasing demand for lake, river, and coastwise vessels which the Commission is authorized to build giving credit for old bottoms turned in.

Paradoxically, American flag foreign service shipping is on a spot with huge loss of traffic under the present neutrality law, and still will be, whatever new law is enacted. Increase in South American tonnage will nowhere near compensate for the Atlantic loss. As yet there have been only vague hints that the government should compensate the lines in some way. Operators are concentrating now on minimizing the restrictions in the writing of the law. If that fails, though they would much prefer to live by profits than by the dole, they will have to ask and accept a subsidy. First evidence of curtailed business showed up in reduced advertising linage in maritime journals and newspapers.

CURB AIRCRAFT EXPANSION

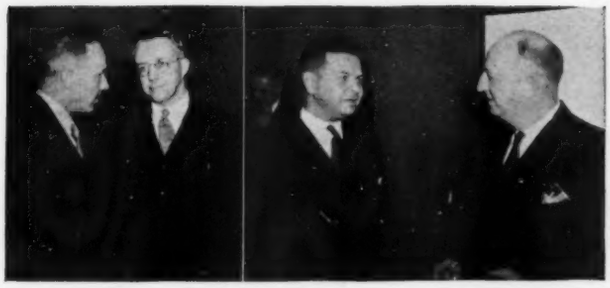
When Washington talks munitions exports to the Allies it thinks of airplanes. Aircraft manufacturers' representatives here are showing a determined stand against expansion of plant that would leave them in the doldrums after Europe's war. Manufacturers are already negotiating with the Treasury to determine what percentage of expansion cost may be allowed for tax reduction. If Army and Navy certify that expansion is necessary, which they would in emergency, important concessions will be made. Expansion for export production, of course, will be charged to the Allies in the form of high airplane prices. In fact it is reliably reported that French have already financed additional plants here. Comment is that aircraft and other industries so far are keeping very level heads on expansion.

Andrews Eased Out

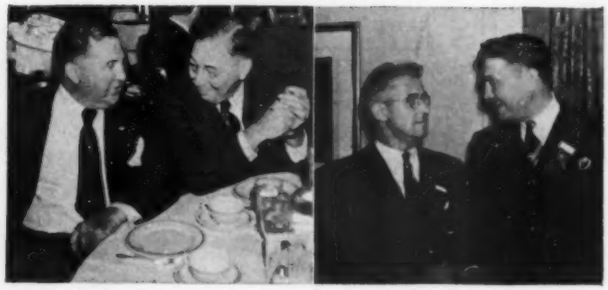
It's not official but Elmer Andrews, Administrator of the wage-hour law, is out. Lt. Col. Philip Fleming, of the Army Engineers, an experienced federal administrator, has been offered the job but had not accepted it at this writing. Andrews performed a Washington miracle of fair dealing with both labor and employers. The town is crawling with theories as to reasons for his departure, but when they're all added up you will find that Sec. Perkins and the CIO demanded a better show of crackdown on industry. It looks like a companion piece with the dismissal of Stettinius and the War Resources Board. Fears are expressed by business visitors here that the mobilization of industry and labor will be New Dealized.

Credit for Allies—Eventually

On the export front: it is estimated France and Britain have about $8,000,000,000 in securities and gold for purchase of munitions, mostly airplanes, if the embargo is repealed. After that is gone they will have to ask for credit in some form. They are loaded to the guards with public debt and taxes. Many competent observers here express private opinion that the Johnson law would be repealed before the Allies would be allowed to sink, or a way would be found around it . . . Roosevelt will ask $100,000,000 for Export-Import Bank instead of $500,000,000. Even Congress and supporters of the Bank thought the latter figure was unnecessarily high. Most of the EIB money will go to South America.



Ford R. Lamb, A.S.T.E. executive secretary, and H. E. Ewart, assistant chief engineer Bantam Bearings Corp., who read a paper prepared by Stanley R. Thomas, Bantam's chief engineer, found time for a talk after the symposium. Right, S. L. Crawshaw of Westinghouse and Eugene Bouton of J. I. Case discussed bearing problems at the Saturday session



Harry Barney and William K. Stamets, rival machine tool dealers in Pittsburgh, attended the dealers meeting and then stayed over for the A.S.T.E. dinner. Herbert D. Hall of New York and Ray Morris of Hartford, at right, are committee chairmen who will be responsible for many of the activities at the A.S.T.E. meeting next March

Symposium on Bearing Application Is Major Feature of A.S.T.E. Semi-Annual Meeting

CLEVELAND—Application, use and misuse of ball, roller, needle and sleeve bearings were discussed at a symposium on bearings during the semi-annual meeting of the American Society of Tool Engineers held at the Statler Hotel here Oct. 6-7. Papers were presented by: H. E. Ewart, assistant chief engineer Bantam Bearings Corp.; Eugene Bouton, supervisor of time study J. I. Case Tractor Works; Karl L. Hermann, consulting engineers; and S. L. Crawshaw, application engineer, gearing division, Westinghouse Electric & Mfg. Co. G. J. Hawkey, president Cleveland Duplex Machinery Co. and chairman of the Cleveland chapter of A.S.T.E., presided. Dr. M. Kronenberg of Cincinnati Milling Machine & Cincinnati Grinders, Inc.; Mr. Bok, chief engineer Kent-Owens Machine Co.; and A. B. Willi, chief engineer Federal-Mogul Corp., took part in the discussion which followed the symposium.

Technological Unemployment Analyzed

At the society's semi-annual dinner on Thursday, John Younger, professor of engineering at Ohio State University, presented a report prepared by the A.S.T.E. fact-finding committee on the effect of machine development on employment and the standard of living. He pointed out that machines are "cost reducing"—not "labor saving"—and that it has been only because of the continued use of the machine that our standard of living has been raised so far above the level in other countries.

Edwin W. Dickett, proposal engineer Sundstrand Machine Tool Co., and Frank R. Crone, chief tool designer Lincoln Motor Car Co., at left, were kept busy as A.S.T.E. national officers. Dr. M. Kronenberg, of Cincinnati Milling Machine & Cincinnati Grinders, took part in the discussion of symposium papers on bearings

Congressman Fish Speaks

Principal speaker at the semi-annual dinner was Congressman Hamilton Fish, ranking Republican member of the House Foreign Affairs Committee. He urged industrial and business leaders to become articulate and swing from the defense to the offense in their efforts to preserve the American industrial system. Congressman Fish termed traffic in arms "immoral and vicious" and stated that he was opposed to the lifting of the arms embargo, but favored a true "cash-and-carry" plan for selling American goods to all buyers.

Other speakers at the dinner were James R. Weaver of Westinghouse, president of the Society, who announced that the board of directors had just voted to hold the March, 1940, annual meeting in New York City, and Tell Berna, general manager of the National Machine Tool Builders Association.

Speakers at the A.S.T.E. semi-annual dinner included Congressman Hamilton Fish of New York, A.S.T.E. president James R. Weaver of Westinghouse, John M. Younger of Ohio State University, and Tell Berna, general manager of the National Machine Tool Builders Association

INTERNATIONAL MACHINE TOOL BOUGHT BY CLEARING MACHINE

INDIANAPOLIS—Clearing Machine Corp., Chicago, Ill., acquired on Oct. 2 the International Machine Tool Co., Inc., of this city, makers of Libby turret lathes. New officers of the International company are R. W. Glasner, president; George W. Pockels, vice-president; Edward J. Terry, vice-president; H. P. Isham, treasurer; George M. Sundheim, secretary; and B. J. Baldwin, assistant secretary. All of the officers, with the exception of Mr. Terry, are associated with the Clearing Machine Corp. Mr. Terry, who will be in charge of manufacture of Libby turret lathes, was formerly with the Caterpillar Tractor Co., Peoria, Ill.

Problems Arising from Boom in Machine Tool Business Discussed by Dealers

CLEVELAND—The place of machine tool dealers in the present situation was discussed at the annual convention of the Associated Machine Tool Dealers of America at the Hotel Cleveland Oct. 5. The convention was limited to a morning session for members only and to a dinner meeting addressed by A. G. Bryant, president Bryant Machinery & Engineering Co., Chicago, retiring president of the association, and James R. Weaver, president American Society of Tool Engineers.

John Sauer, Jr., Peninsular Machinery Co., Detroit, was elected president of the association. Other officers are F. B. Scott, Jr., Syracuse Supply Co., Syracuse, N. Y., vice-president; and George F. Turner, Strong, Carlisle & Hammond Co., Detroit, secretary-treasurer. Members of the executive committee whose terms expire in 1942 are D. N. Macconel, Machinery Sales Co., Los Angeles; L. H. Pratt, Henry Prentiss & Co., Inc., New York; and G. J. Hawkey, Cleveland Duplex Machinery Co., Inc., Cleveland. John P. Tierney, General Machinery Corp., Boston, is a member of the executive committee, his term expiring in 1940.

"The machine tool industry, vital because it includes all the machinery on which most present-day equipment is produced, must in protection of itself and as a service to American business, limit the amount of export sales which it can accept," said Mr. Bryant in his address "What Price Machine Tools?" "It must be prepared to handle our own government's requirements for machinery for Navy yards and arsenals and to meet with as reasonable delivery service as possible the needs of its regular customers."

Mr. Bryant pointed out that in only six years out of the past twenty has the national sales volume of machine tools equalled that of 1926. In the summer of 1938 sales dropped to one-quarter the volume in the spring of 1937. Resulting losses have seriously handicapped the industry. Yet "our national defense is utterly dependent on having a strong machine tool industry to provide tanks, ships, guns and munitions."

He commented on the fact that the war, far from benefiting the machine tool industry, has come at a time which seriously interferes with the job of handling the present industrial market for machinery. The sudden load placed on machine tool builders has resulted in prolonging deliveries to normal customers as much as six months to a year and in creating the danger of increased prices.

Mr. Weaver stressed the fact that machine tools being shipped to Europe today will be converted from war uses to manufacture of peacetime products after the conflict, thus providing stiff competition for American products. Under the circumstances, U.S. plant equipment must be kept modern. He paid tribute to the help that dealers have been to him in the purchase of machine tools at Westinghouse.

U. S. Government Contracts Awarded to Metal-Working Firms

(Last-minute awards on page 876b)

Contractor	Gov't Agency	Commodity	Amount
E. Behringer Sheet Metal Works, Inc., Newark, N. J.	Navy, S. & A.	Shells	$30,375
Beatrice Steel Tank Mfg. Co., Beatrice, Neb.	Agriculture	Bins	52,188
Riverside Metal Co., Riverside, N. J.	Treasury	Penny blanks	38,250
Elliott Co., Ridgway, Pa.	War, Air Corps	Blowers	26,650
Brown & Sharpe Mfg. Co., Providence, R. I.	Navy; War	Milling machines	85,418
Hardinge Brothers, Inc., Elmira, N. Y.	War, Ordnance	Lathes	24,670
Cincinnati Milling Machines & Cincinnati Grinders, Inc., Cincinnati, Ohio	War, Ordnance	Milling machines	43,254
Van-Dyck Churchill Co., New York, N. Y.	War, Ordnance	Milling machines	13,917
American Machine & Metals, Inc., East Moline, Ill.	War, Ordnance	Testing machines	13,327
Kearney & Trecker Corp., Milwaukee, Wis.	War; Navy	Milling machines	43,813
Foote-Burt Co., Cleveland, Ohio	War, Ordnance	Broaching machine	18,165
Warner & Swasey Co., Cleveland, Ohio	Navy, S. & A.	Turret lathes	11,750
Pratt & Whitney Div., Niles-Bement-Pond Co., Hartford, Conn.	War, Ordnance	Machine tools	47,470
Addressograph Multigraph Corp., Addressograph Div., Cleveland, Ohio	Procurement	Addressing machine	47,100
Sharples Corp., Philadelphia, Pa.	Navy, S. & A.	Oil purifiers	34,951
Caterpillar Tractor Co., Peoria, Ill.	War, Q. M. C.	Tractors	77,353
M. L. Bayard & Co., Philadelphia, Pa.	Navy, S. & A.	Winches	29,500
Acme Coppersmithing & Machine Co., Oreland, Pa.	War, Ordnance	Chemical equipment	96,000
RCA Mfg. Co., Camden, N. J.	C. A. A.	Receiving equipment	33,181
Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.	Navy, S. & A.	Airplanes	1,786,860
Pioneer Instrument Co., Bendix, N. J.	Navy, S. & A.	Aircraft instruments	131,775
Eclipse Aviation Div., Bendix Aviation Corp., Bendix, N. J.	Navy, S. & A.	Aircraft starters	43,614
The Midvale Co., Nicetown, Pa.	Navy, S. & A.	Steel forgings	26,100
Bethlehem Steel Co., Bethlehem, Pa.	Navy, S. & A.	Steel forgings	609,000
Crucible Steel Co. of America, Harrison, N. J.	Navy; War	Steel forgings	114,675
Steel Improvement & Forge Co., Cleveland, Ohio	Navy, S. & A.	Steel forgings	51,175
Treadwell Construction Co., Midland, Pa.	T.V.A.	Radial gates	38,661
Mitchell Metal Products, Inc., Cleveland, Ohio	Navy, S. & A.	Practice bombs	87,325
Lundquist Tool & Mfg. Co., Worcester, Mass.	War, Signal Corps	Reels	34,812
American Brass Co., Torrington, Conn.	War, Ordnance	Brass cups	40,740
Revere Copper & Brass, Inc., Baltimore Div., Baltimore, Md.	Panama Canal	Brass pipe	31,327
Pressed Steel Tank Co., West Allis, Wis.	Newport torpedo station	Bronze shells	22,041
Bridgeport Brass Co., Bridgeport, Conn.	War, Ordnance	Disks, gilding metal	156,722
Baldwin-Southwark Corp., Eddystone, Pa.	T.V.A.	Turbines	784,992
Rockford Machine Tool Co., Rockford, Ill.	Navy, S. & A.	Slotting machine	15,925
Henry Prentiss & Co., New York, N. Y.	Navy, S. & A.	Turret lathes	30,863
Wm. Sellers & Co., Philadelphia, Pa.	Navy Yard	Planer parts	10,600
Ex-Cell-O Corp., Detroit, Mich.	War, Ordnance	Shell turning machines	35,809
Baldwin-Southwark Corp., Eddystone, Pa.	Navy, S. & A.	Hydraulic equipment	47,607
Ingersoll-Rand Co., Phillipsburg, N. J.	War, Air Corps	Exhausters, blowers	222,300
Allis-Chalmers Mfg. Co., Milwaukee, Wis.	Interior; War	Blowers, circuit breakers	168,160
General Electric Co., Schenectady, N. Y.	T.V.A.; W.P.A.;	Electrical equipment	3,772,197
Beech Aircraft Corp., Wichita, Kan.	War, Air Corps	Airplanes	458,764

OTIS HEADS DODGE MFG.

MISHAWAKA, Ind.—At a meeting of the board of directors of Dodge Mfg. Corp. held Monday afternoon, Oct. 2, Joseph E. Otis, Jr., was elected president of the corporation to succeed George C. Miller, who died May 10. Mr. Otis will take office Nov. 1.

He comes to Dodge Mfg. Corp. from the presidency of Stewart-Warner Corp. of Chicago, to which office he was elected in 1933. Prior to his election as president of Stewart-Warner, he was for ten years vice-president and general manager of Alemite Corp. He is in addition a director of Central Republic Co., Chicago, and of Outboard Marine & Mfg. Company of Milwaukee.

PERSONALS

GEORGE L. ABBOTT has joined Graton & Knight Co., Worcester, Mass., industrial leather products manufacturer as a director, a vice-president, and general sales manager.

H. E. ANKENEY has been placed in charge of the Indianapolis territory of Cutler-Hammer, Inc., Milwaukee, Wis.

W. F. DALY, formerly on the staff of Allis-Chalmers Mfg. Co.'s Chicago office, has been appointed district office manager at St. Louis. C. L. ORTH, for the past 29 years manager of that office, will continue in a consulting and sales capacity.

DAVID FINDLAY, formerly first vice-president and general sales manager of the L. S. Starrett Co., Athol, Mass., has been elected president, succeeding FRANK A. BALL, who has been named chairman of the board of directors. ARTHUR H. STARRETT, formerly second vice-president, has been named vice-president, and WILLIAM J. GREEN, former Eastern sales manager has been made general sales manager of the company. LLOYD I. WILLIAMS, formerly Pacific Coast representative, has been appointed Pacific Coast sales manager.

In the manufacturing department, R. J. O. SIMPSON retires as superintendent to become consulting engineer, while WILLIAM D. STARRETT, formerly assistant superintendent, has been named superintendent. WILLIAM A. THORP, former engineer, becomes assistant superintendent.

R. B. MOIR, recently resigned as chief engineer of W. A. Jones Foundry & Machine Co., has become associated with the Foote Bros. Gear & Machine Corp., Chicago, Ill., as director of sales research and engineering development.

JOHN DOLZA, formerly assistant chief engineer of the Buick Div. of General Motors Corp., Flint, Mich., has been named special project engineer assigned to advanced development problems. He is succeeded by EDWARD T. RAGSDALE, for the past several years body engineer, who will retain direct supervision over all body and sheet metal engineering activities. VERNER P. MATHEWS, for the past twelve years an engineer in the chassis division of the organization, becomes chassis engineer in charge of all chassis engineering activities. JAMES H. BOOTH, who since 1935 has specialized in steering, suspensions and other developments having to do with ride and handling, becomes chassis division engineer in charge of that phase of car design and construction. EDWARD F. REYNOLDS, formerly assistant body engineer, becomes body division engineer.

DAVID FINDLAY

LAWRENCE E. JOSEPH

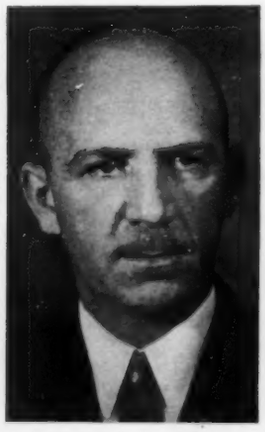
CHARLES E. VAN NORMAN

LAWRENCE E. JOSEPH, recently appointed executive head of the Blaw-Knox Div., Blaw-Knox Co., Pittsburgh, Pa., has been elected a director and vice-president.

CHARLES E. VAN NORMAN, president of Van Norman Machine Tool Co., Springfield, Mass., Celebrated his 80th birthday Oct. 6.

Born in Hamilton, Ontario, Mr. Van Norman went to work at the age of seventeen for the Hopkins Watch Tool Co. of Waltham, Mass. For nine years he was a part owner of this business. He sold his interest to his brothers and for three years was connected with various other organizations, later returning to Waltham and joining his brothers in carrying on the company, the name of which had been changed to Waltham Watch Tool Co. In 1890 it was moved to Springfield and duplex milling machines and ball race grinding machines added to its line. In 1912 the name was changed to Van Norman Machine Tool Co., which has since acquired the Franklin Machine & Tool Co. of Springfield, the AFF Machine Co., of San Francisco, and the Producto Machine Co. of Bridgeport.

JOHN DOLZA



EDWARD T. RAGSDALE

VERNER P. MATHEWS

BUSINESS ITEMS

American Cutter & Engineering Co., Detroit, Mich., has begun manufacture of a line of high-speed metal-cutting tools. The company is equipped to manufacture all types of milling cutters, reamers, counterbores, forming tools, etc., and will provide a complete engineering service to help the metal-working industry in its cutter problems. Officers of the company include GERALD H. READER, president: ARLO J. HILLYARD, vice-president; MILTON PRICE, secretary-treasurer, and WELDON C. ELLIOTT, in charge of production.

Baker Oil Tools, Los Angeles, Calif., has been issued a building permit for the construction of a new office building to cover an area of approximately 7,000 sq.ft. and cost $40,000.

John S. Barnes Corp., Rockford, Ill., has opened a Detroit district sales office at 503 New Center Bldg., Detroit, Mich. ARNOLD J. WERNER, for the past several years sales engineer for H. R. Krueger & Co., will be in charge. Standard Barnes hydraulic pumps, valves, units, panels and cylinders, as well as special engineering service, will be available through the new office. The line of Barnes sliding head units, drilling and boring units, square ram and self-contained units manufactured by the W. F. & John Barnes Co. will also be sold exclusively through this office.

Electroloy Co., New York, N. Y., has leased a portion of the Bridgeport, Conn., plant formerly occupied by the International Silver Co. and owned by the Stanley Works, Inc., to engage in the manufacture of electrodes for the automobile industry. T. S. DONALD is general manager.

J. Milton Luers, Detroit, Mich., manufacturer of cutting-off and

threading tools, has moved to 20 Pine St., Mt. Clemens, Mich.

National Broach & Machine Co., Detroit, Mich., is planning to hold a machine tool show of its own during the week of Oct. 16-21. At this time the company will demonstrate all the machines which were to have been presented at the National Machine Tool Show in Cleveland. Exhibition will be held in a part of the new addition to the organization's plant at Shoemaker & St. Jean Sts., which is rapidly nearing completion. This addition, which will provide 17,000 extra sq.ft. of floor space, is the fourth in four years.

North American Aviation, Inc., Los Angeles, Calif, has awarded contract for construction of a one-story and mezzanine aircraft factory, with basement, to cover an area of 200,000 sq.ft. at Los Angeles Municipal Airport.

Ransome Concrete Machinery Co., Dunellen, N. J., has appointed the Fuchs Machinery & Supply Co., Omaha, Neb., as distributor for its line of welding tables and positioners in Nebraska and Iowa.

Putnam Tool Co., Detroit, Mich., has completed a new plant addition made necessary to meet the increasing demand for the company's line of end mills and other cutting tools.

Vultee Aircraft Div. of Aviation Mfg. Corp., Downey, Calif., has begun a plant expansion program involving the addition of 200 ft. to the south side of its main factory building and 60 ft. to the back of the final assembly building along with a further addition made between the latter and the main factory building to tie the two together.

OBITUARIES

OSCAR HARMER, PROMINENT MACHINE TOOL BUILDER, DIES

COVENTRY, ENGLAND — OSCAR HARMER, for many years general manager of Alfred Herbert, Ltd., died here Wednesday, Oct. 11. Mr. Harmer, who would have been 90 years young on Oct. 23, spent his early years with Brown & Sharpe Mfg. Co. in Providence, R. I., and is well known in the machine tool industry in this country. Despite his advanced age, he was active in business until very recently.

GEORGE W. KAEPPEL, 81, a machinist at the Allis-Chalmers Mfg. Co., West Allis, Wis., for 37 years, died Sept. 28.

HARRY LINDBERG, at one time production manager for the Cadillac Motor Car Co., died Sept. 30 in Detroit. He was plant manager of the Fisher Body St. Louis plant after leaving Cadillac, and more recently was sales engineer for the Motor Products Corp. of Detroit.

JOHN MILLER, JR., general superintendent of Charles H. Besly & Co., Chicago, Ill., died Aug. 20 at a hospital in that city.

JOHN M. B. SCHEELE, 66, of Maplewood, N. J., and a sales representative for the Ingersoll Milling Machine Co., Rockford, Ill., died Oct. 1.

MEETINGS

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS. Annual meeting, Blackstone Hotel, Chicago, Ill., Oct. 23-28.

AMERICAN SOCIETY FOR METALS. Twenty-first annual meeting, Palmer House, Chicago, Ill., Oct 23-28.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Sixtieth annual meeting, Bellevue-Stratford Hotel, Philadelphia, Pa., Dec. 4-8.

AMERICAN WELDING SOCIETY. Twentieth annual meeting, Stevens Hotel, Chicago, Ill., Oct. 23-28.

INDUSTRIAL MANAGEMENT SOCIETY. National time and motion study clinic, Medinah Club, Chicago, Ill., Nov. 3 and 4.

MOTOR AND EQUIPMENT MANUFACTURERS ASSOCIATION. Annual meeting, Blackstone Hotel, Chicago, Ill., Dec. 12.

NATIONAL AUTOMOBILE SHOW. Fortieth national automobile show, Grand Central Palace, New York, N. Y., Oct. 15-22.

NATIONAL METAL EXPOSITION, International Amphitheater, Chicago, Ill., Oct. 23-28.

NATIONAL SAFETY COUNCIL. Twenty-eighth national safety congress, Atlantic City, N. J., Oct. 16-20.

PORCELAIN ENAMEL INSTITUTE. Fourth annual forum, Ohio State University, Columbus, Ohio, Oct. 18-20.

SOCIETY OF AUTOMOTIVE ENGINEERS. Annual dinner, Hotel Pennsylvania, New York, N. Y., Oct. 16. National transportation meeting, Hotel Coronado, St. Louis, Mo., Oct. 26 and 27. National fuels and lubricants meeting, Mayo Hotel, Tulsa Okla., Nov. 2 and 3.

WIRE ASSOCIATION. Annual meeting, Congress Hotel, Chicago, Ill., Oct. 23-28.

Exports of Machinery During August, 1939

	August 1939	July 1939	August 1938
Electrical machinery	$8,696,318	$8,988,257	$8,084,328
Power generating machinery except automotive and electric	1,560,056	1,154,835	1,384,950
Construction and conveying machinery	2,450,330	2,912,134	1,933,230
Mining, well and pumping machinery	5,613,157	4,940,898	5,240,719
Power driven, metal-working machinery	9,870,911	9,358,876	8,625,729
Other metal-working machinery	439,774	340,843	332,580
Textile machinery	753,699	620,100	449,557

Exports of Metal-Working Machinery During August, 1939

Engine lathes	$511,526	$554,419	$862,288
Turret lathes	847,477	698,572	296,500
Other lathes	451,747	317,785	181,034
Vertical boring mills and chucking machines	345,972	638,737	500,452
Thread cutting and automatic screw machines	568,977	528,345	187,892
Knee and column type milling machines	378,887	628,809	332,223
Other milling machines	1,307,131	1,223,758	1,214,704
Gear cutting machines	236,851	331,371	236,361
Vertical drilling machines	27,610	106,998	105,030
Radial drilling machines	74,503	24,609	17,450
Other drilling machines	139,089	140,191	142,144
Planers and shapers	338,547	342,717	256,416
Surface grinding machines	179,209	283,993	338,304
External cylindrical grinding machines	184,612	209,248	429,427
Internal grinding machines	465,997	480,129	386,792
Tool grinding, cutter grinding and universal grinding machines	436,371	283,034	306,150
Other metal-grinding machines and parts	425,013	374,756	210,275
Sheet and plate metal-working machines and parts	612,220	353,550	689,867
Forging machinery and parts	359,648	301,374	95,404
Rolling mill machinery and parts	755,812	588,126	874,220
Foundry and molding equipment and parts	118,476	78,769	228,787
Other power-driven metal-working machinery and parts	1,103,455	829,356	734,009

Other Metal-Working Machinery

Pneumatic portable tools	$146,365	$91,378	$84,042
Other portable and hand or foot-operated metal-working machines and parts	133,609	103,354	109,902
Chucks for machine tools	21,906	28,735	29,368
Milling cutters, machine-operated threading dies and taps, and similar machine-operated metal cutting tools	73,228	51,058	36,749
Other metal-working machine tools and parts	64,666	66,418	72,519

W. P. WOODSIDE, Climax Molybdenum Company, has presided over the American Society for Metals since fall of the past year.

JAMES P. GILL, Vanadium Alloys Steel Corporation and A.S.M. vice-president, will preside over the society during the coming year.

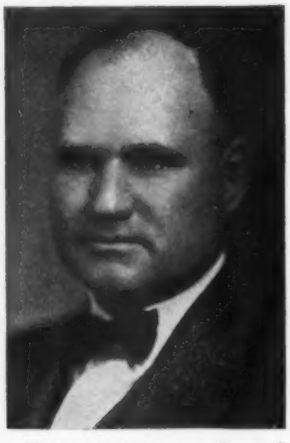
DR. OSCAR E. HARDER, Battelle Memorial Institute, has been chosen to take Mr. Gill's place as vice-president of the organization.

OFFICERS OF THE AMERICAN SOCIETY FOR METALS

HOWARD SCOTT and F. W. Trembour of Westinghouse Electric will present methods for evaluation of steel hardening media.

J. L. BURNS and Victor Brown, Republic Steel Corporation, will present a paper outlining recent findings in the field of time quenching.

H. Y. HUNSICKER, Aluminum Company of America, will discuss precipitation hardening characteristics of high-purity aluminum alloys.



ZAY JEFFRIES, General Electric Company, will deliver the introduction to the symposium on precipitation hardening of metals.

Metal Men to Meet Again

THOUGH METALS have long since come into their own as materials of construction and of machine fabrication, once a year additional knowledge gained as to their use becomes the major topic of many men attending the National Metal Congress and Exposition.

This year metallurgists and metal makers, fabricators and users will gather in Chicago the week of Oct. 23 to compare notes on their findings in laboratory, field and shop. As always since the inception of the Congress and Exposition, their exchange of ideas will eventually materialize in better ways of processing metals and in new uses for them. With space already reserved for some 220 exhibitors, the Exposition seems predestined for success. One estimate puts the number of persons expected to attend at a figure close to 10,000.

Sponsoring the Congress are the American Society for Metals, the American Welding Society, the American Institution of Mining and Metallurgical Engi-

E. C. BAIN, United States Steel Corporation, will deliver a series of educational lectures on effects of alloying elements in steel.

neers and the Wire Association. All four of these organizations have arranged comprehensive programs including meetings, banquets, technical sessions and plant trips.

Outstanding among the activities of the week are plans made by the American Society for Metals. With headquarters at the Palmer House, this association has scheduled thirteen technical sessions in addition to a series of educational lectures, its annual meeting, and other regular activities. At this meeting officers for the coming year will be installed. James P. Gill, for the past year vice-president of the organization, will succeed W. P. Woodside as president, while Dr. Oscar E. Harder will take over the duties of vice-president.

Coincident with the change of officers made effective by the American Society for Metals, the American Welding Society will also install officers for the 1939–1940 term. Replacing H. C. Boardman as president will be George T. Horton, while Turner C. Smith and Leon Moisseiff will be inaugurated as first and second vice-presidents respectively. Fifteen technical sessions have been planned, with several inspection trips also on the schedule. Chicago meeting headquarters of the society will be at the Hotel Stevens.

As in recent years a highlight of the American Society for Metals activities will be the educational courses. For the coming meeting these will consist of several explanations of the functions of alloying elements in steel by H. C. Bain, United States Steel Corporation, and discussions of visual examination of steels by G. M. Enos, University of Cincinnati. Also featured during the Congress will be a symposium on precipitation hardening of metals, introduced by Zay Jeffries of General Electric.

GEORGE T. HORTON has been selected to succeed Mr. Boardman as president of the A.W.S.

TURNER C. SMITH has been nominated by members of the A.W.S. to serve as first vice-president.

LEON S. MOISSEIFF has been chosen to serve the A.W.S. as second vice-president during the coming term.

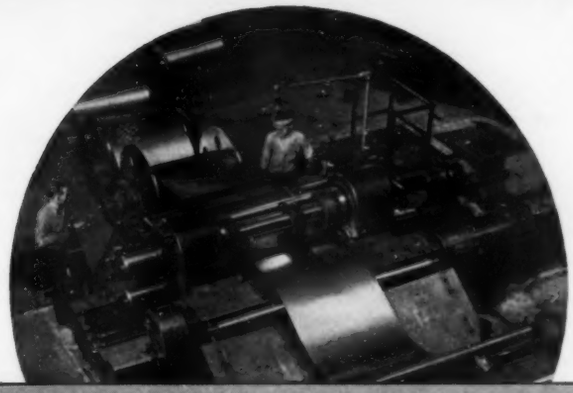
H. C. BOARDMAN, Chicago Bridge and Iron Company, for the past year has headed the A.W.S.

LEADING PERSONALITIES OF THE AMERICAN WELDING SOCIETY

H. J. FRENCH and T. N. Armstrong, International Nickel Company, will present a paper on some aspects of the welding of alloy steels.

S. M. HUMPHREY, Taylor Winfield Corporation, is planning to review many of the engineering fundamentals of resistance welding.

W. W. PETRY, Cincinnati Milling Machine Company, will analyze factors influencing the flow of materials in production welding.



NATIONAL METAL EXPOSITION

INTERNATIONAL AMPITHEATER, CHICAGO, OCTOBER 23–28, 1939

LIST OF EXHIBITORS

ACME STEEL CO., *(312) Strip steels with plain and galvanized finishes.*

AIR REDUCTION SALES CO., *(M-319). Demonstrations of automatic welding, flame hardening, cutting and cleaning.*

AJAX ELECTRIC CO., *(A-101). Salt bath furnaces.*

AJAX ELECTROTHERMIC CORP., *(A-101) High frequency converters with demonstration furnaces.*

ALLEGHENY LUDLUM STEEL CORP., *(C-117). Allegheny Metal, Ludlite, examples of welding, spinning, drawing and machining.*

EDGAR ALLEN STEEL CO., *(E-120). Tool and die steels.*

ALOX CORP., *(B-130). Anti-corrosion products.*

ALUMINUM CO. OF AMERICA, *(G-201). Display of aluminum and magnesium alloys. Furnace brazing of aluminum.*

AMERICAN BRAKE SHOE & FOUNDRY CO.,

AMERICAN MANGANESE STEEL CORP., *(N-311). Heat-treating containers.*

AMERICAN BRASS CO., *(A-104). Alloys, forgings, extrusions and die castings. Welding rods.*

AMERICAN CAR & FOUNDRY CO., *(C-106). Rivet, bar and forging heaters.*

AMERICAN CHAIN & CABLE CO., ANDREW C. CAMPBELL DIV., *(M-323). Abrasive cut-off machines.*

AMERICAN CHAIN & CABLE CO., PAGE STEEL & WIRE DIV., *(M-323). Welding wires and electrodes, also wire made from carbon and stainless steels.*

AMERICAN CYANIMID & CHEMICAL CORP., *(A-132). Case hardening compounds, chemicals.*

AMERICAN FOUNDRY EQUIPMENT CO., *(L-323). Airless abrasive blasting machines.*

AMERICAN GAS ASSOCIATION, *(Combined Industrial Gas Exhibit). Gas heat-treating and melting equipment.*

AMERICAN GAS FURNACE CO., *(Combined Industrial Gas Exhibit).*

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, *(J-320). Educational exhibit.*

AMERICAN MACHINE & METALS, INC., RIEHLE TESTING MACHINE DIV., *(A-117). Impact, hardness and universal testing machines.*

AMERICAN MACHINIST, *(I-212).*

AMERICAN MANGANESE STEEL CO., *(N-311). Heat-treating containers, small furnace castings.*

AMERICAN ROLLING MILL CO., *(E-101). Stainless steels, enameling iron, sheets and plates.*

AMERICAN SCREW CO., *(E-132). "American Plus" Phillips screws.*

AMERICAN STEEL & WIRE CO., *(G-205). Wire, rods and strip steel.*

AMERICAN WELDING SOCIETY, *(C-121). Educational exhibit.*

AMPCO METAL, INC., *(C-118). Non-ferrous alloy parts.*

ANDRESEN, INC., *(J-315).*

ARCOS CORP., *(L-304). Arc-welded stainless steel products.*

ARMSTRONG CORK CO., *(K-322). Ingot mold insulation for killed steel.*

AUDUBON WIRE CLOTH CORP., *(N-329). Flexible woven wire conveyor belts.*

AUTOMATIC GASFLUX, INC., *(C-107). Fluxes automatically fed into gas line for welding operations.*

BABCOCK & WILCOX CO., *(B-107). Refractories.*

BALDWIN-SOUTHWARK CORP., *(D-118). Testing machines.*

W. O. BARNES CO., *(C-102). Hacksaw blades.*

BASTIAN-BLESSING CO., *(I-205). Welding and cutting apparatus.*

BAUSCH & LOMB OPTICAL CO., *(D-119). Metallographic equipment and optical shop tools.*

BETHLEHEM STEEL CO., *(L-319). Mayari R steel, hot and cold rolled strip steels.*

BINKS MFG. CO., *(C-137). Spray painting equipment.*

G. S. BLAKESLEE & CO., *(N-317). Metal cleaning apparatus.*

BLISS & LAUGHLIN, INC., *(M-305). Cold finished bar steels.*

BRISTOL CO., *(L-325). Control instruments.*

BROWN INSTRUMENT CO., *(D-123). Indicating, recording and controlling instruments.*

ADOLPH I. BUEHLER, *(E-117). Metallographic sample preparation equipment.*

CAMBRIDGE WIRE CLOTH CO., *(C-103). Flexible woven wire conveyor belts, mesh baskets, heat and corrosion resisting screen.*

CARBOLOY CO., *(F-210). Cemented carbide tools.*

CARNEGIE-ILLINOIS STEEL CO., *(G-205). Alloy steels, structural shapes.*

CARPENTER STEEL CO., *(B-120). Heat-treating of tool steels.*

CENTRAL SCIENTIFIC CO., *(M-315). Chemical laboratory equipment.*

CHASE BRASS & COPPER CO., *(L-301). Tellurium coppers, other copper alloys.*

CHICAGO SCREW CO., *(M-317). Screw machine products.*

CHICAGO STEEL FOUNDRY CO., *(C-105). Heat and corrosion resisting alloys.*

CLEVELAND QUARRIES CO., *(A-138). "Buckeye" silica firestone.*

CLIMAX MOLYBDENUM CO., *(L-334). Reception space.*

COLUMBIA STEEL CO., *(G-205). Alloy steel shapes.*

COLUMBIA TOOL STEEL CO., *(K-313). Steel steels.*

COMPRESSED INDUSTRIAL GASES, INC., *(N-331). Oxygen, acetylene and hydrogen, welding and cutting apparatus.*

CONTINENTAL INDUSTRIAL ENGINEERS, *(Combined Industrial Gas Exhibit). Annealing and heat-treating furnace.*

CONTINENTAL MACHINES, INC., *(D-101). Band sawing and filing machines.*

CONTINENTAL ROLL & STEEL FOUNDRY CO., *(L-330). Polishing and buffing equipment.*

CROWN RHEOSTAT & SUPPLY CO., *(L-329). Polishing and plating equipment.*

CRUCIBLE STEEL CO. OF AMERICA, *(N-322). Tool steels.*

DARWIN & MILNER, INC., *(J-309). Tool steels.*

DAYTON ROGERS MFG. CO., *(M-303). Power press cushion equipment, metal stampings.*

A. P. DE SANNO & SON, INC., *(N-312). Abrasive cut-off machines, grinding wheels, portable tool grinder.*

DESPATCH OVEN CO., *(Combined Industrial Gas Exhibit). Furnaces and heaters.*

DETROIT TESTING MACHINE CO., *(A-113). Universal testing machine, hardness and ductility testers.*

HARRY W. DIETERT CO., *(B-119). Analysis equipment.*

DILL MFG CO., *(K-317). Screw machine products, metal stampings.*

DOW CHEMICAL CO., *(M-302). Dowmetal magnesium alloys.*

DRIVER-HARRIS CO., *(J-305). Corrosion-resisting castings and furnace parts.*

E. I. DU PONT DE NEMOURS & CO., *(A-111). Industrial chemicals.*

DURALOY CO., *(N-301). Centrifugally cast screw conveyor, furnace trays, doors, rails and rollers.*

DURANT MFG. CO., *(M-304). Productimeters, wire measuring machines.*

ECCO HIGH FREQUENCY CORP., *(K-316).* ECLIPSE FUEL ENGINEERING CO., *(Combined Industrial Gas Exhibit). Furnaces, heaters and burners.*

ELECTRICAL FURNACE CO., *(I-202). Photographs of recent furnace installations.*

ELECTRO-ALLOYS CO., *(A-102). Heat and corrosion resisting castings.*

ELECTRO METALLURGICAL CO., *(L-301). Alloy steels and cast irons.*

JAMES L. ENTWISTLE, *(M-304).*

FAHRALLOY CO., *(A-135).*

FEDERAL MACHINE & WELDER CO., *(A-137). Spot welding machines.*

FEDERAL PRODUCTS CORP., *(K-307). Precision gages.*

A. FINKL & SONS CO., *(C-132). Tool steels, improved die blocks.*

FIRTH-STERLING STEEL CO., *(C-101). Cemented carbide tools, Chromovan dies, stainless steel.*

FISHER SCIENTIFIC CO., *(M-308). Laboratory equipment.*

FITZSIMONS CO., *(G-212).*

FOOTE BROS. GEAR & MACHINE CO., *(B-135). "Deephard" steels.*

J. B. FORD CO., *(E-126). Metal cleaning solutions, burnishing compounds.*

FOXBORO CO., *(K-305). Indicating, recording and controlling instruments.*

GENERAL ALLOYS CO., *(F-205). Corrosion- and acid-resistant furnace parts.*

GENERAL ELECTRIC CO., *(A-110). Electric heating and welding equipment.*

GENERAL ELECTRIC X-RAY CORP., *(A-120). Hayes X-Ray diffraction unit, illuminated radiographs.*

GLOBAR DIV., CARBORUNDUM CO., *(J-317). Globar-equipped furnaces.*

CLAUD S. GORDON CO., *(A-113). Selective carburization.*

GREENLEE FOUNDRY CO., *(E-125). Meehanite castings.*

GROB BROS., *(J-308). Diemaking machines, band sawing and filing machines.*

GUYER METAL PRODUCTS CORP., *(C-120).*

HALCOMB STEEL CO., *(N-322). Tool steels and alloy steels.*

HANDY & HARMAN, *(E-107). Production brazing.*

CHARLES HARDY, INC., *(B-108). Hardy-Lepel high-frequency sintering furnace, new brazing powder.*

HARNISCHFEGER CORP., *(B-122). Type WA-200 square frame welders, P&H hoists, welding electrodes.*

HARVEY METAL CORP., *(I-124).*

HAUCK MFG. CO., *(I-213). Oil and gas burners, regulating valves.*

C. I. HAYES, INC., *(B-102). Heat-treating furnaces.*

HAYNES-STELLITE CO., *(L-301). Hard facing materials, metal-cutting tools, corrosion and wear resistant alloys.*

HEPPENSTALL CO., *(123)*

HEVI DUTY ELECTRIC CO., *(K-319). Electric heat-treating furnaces.*

HOBART BROS. CO., *(J-301). Arc welders.*

HOLCROFT & CO., *(B-121).*

HOLLUP CORP., *(N-331). Electric arc welders, electrodes and equipment.*

CHARLES A. HONES, INC., *(Combined Industrial Gas Exhibit). High speed atmospheric oven furnace, pot furnaces.*

E. F. HOUGHTON & CO., *(M-311). Liquid carburizing baths, cutting oils, alkaline cleaners, anti-scaling compound.*

HOWELL INDUSTRIAL TRUCK CO., *(A-134). Materials handling equipment.*

ILLINOIS TESTING LABORATORIES, INC., *(I-210). Indicating, recording and controlling instruments.*

INDEPENDENT PNEUMATIC TOOL CO., *(M-326). Portable electric tools.*

INGERSOLL STEEL & DISC CO., *(J-307).*

INTERNATIONAL NICKEL CO., *(C-125). Alloys containing nickel.*

JOHNS-MANVILLE, *(E-105). Insulating and refractory materials.*

JONES & LAUGHLIN STEEL CORP., *(B-117). "Flame Controlled" Bessemer steels.*

J. W. KELLEY CO., *(L-308). Heat-treating products.*

M. W. KELLEY CO., *(L-306). Welded pressure vessels.*

C. M. KEMP MFG. CO., *(Combined Industrial Gas Exhibit). Gas burners, radiators, immersion melting units.*

KREMBS & CO., *(A-105). Welding equipment.*

KROPP FORGE CO., *(K-334). Forged shafts, connecting rods, gears.*

KROUSE FATIGUE TESTING MACHINE CO., *(J-310). Fatigue testing equipment.*

LA SALLE STEEL CO., *(J-304). "Stressproof" steels.*

LATROBE ELECTRIC STEEL CO., *(L-315). Tool steels.*

LAVA CRUCIBLE CO., *(K-314). Refractories, cements.*

R. LAVIN & SONS, *(107).*

LEEDS & NORTHRUP CO., *(J-313). Indicating, recording and controlling instruments.*

LEPEL HIGH FREQUENCY LABORATORIES, *(B-110).*

C. F. L'HOMMEDIEU & SONS CO., *(M-329). Polishing and plating equipment.*

LINCOLN ELECTRIC CO., *(H-205). Arc welders and welding electrodes.*

LINDBERG ENGINEERING CO., *(F-202). Heat-treating furnaces.*

LINDE AIR PRODUCTS CO., *(L-302). Oxyacetylene welding and cutting equipment, flame hardening equipment, and "Unionmelt" welding process.*

MACHINERY & WELDER CORP., *(A-108). Ransome welding tables, gas and electric welding equipment.*

PAUL MAEHLER CO., *(Combined Industrial Gas Exhibit).*

MAGNAFLUX CORP., *(C-119). Equipment for "Magnaflux" testing.*

MAGNETIC ANALYSIS CORP., *(J-314). Magnetic analysis equipment.*

MAHR MFG. CO., *(A-119). Nitrogen generator.*

P. R. MALLORY & CO., *(K-320). Nonferrous alloys, spot welding tips, welding disks and dies, welding tip holders.*

MANGANESE STEEL FORGE CO., *(N-329). "Rol-Man" manganese steel.*

MANHATTAN RUBBER MFG. CO., *(E-122). Abrasive cut-off and finishing wheels.*

You are invited to visit the

AMERICAN MACHINIST

Booth No. I-212

while at this exhibition

MARBURG BROS., INC., *(J-323). Cutting tools, gages, Moore jig borer and rotary table.*

MAURATH, INC., *(B-123). Welding electrodes.*

MCKAY CO., *(A-129). Welding electrodes, industrial chain.*

METAL & THERMIT CORP., *(D-125). Welding electrodes.*

METALLIZING CO. OF AMERICA, *(N-304).*

METALS DISINTEGRATING CO., *(D-108).*

MICHIANA PRODUCTS CORP., *(B-137). Stainless steel and abrasion-resistant castings, furnace conveyors.*

MIDVALE CO., *(E-118). Forgings, extrusion press parts.*

A. MILNE & CO., *(E-120). High speed steels, alloy steels, graphitic steels.*

MOLYBDENUM CORP. OF AMERICA, *(H-211). Metal powders.*

NATIONAL CYLINDER GAS CO., *(A-126). Oxyacetylene welding and cutting equipment.*

NATIONAL TUBE CO., *(G-205). Alloy tube products.*

NEW JERSEY ZINC SALES CO., *(L-311). Zinc alloy die castings.*

OHIO CRANKSHAFT CO., *(K-331). Tocco heat-treating equipment.*

TINIUS OLSEN TESTING MACHINE CO., *(J-325). Universal testing machines, hardness, ductility and stiffness testers.*

OSBORN MFG. CO., *(M-307). Industrial brushes.*

PAGE STEEL & WIRE DIV., *(M-323). Welding wires and electrodes.*

PANGBORN CORP., *(F-211). Abrasive blasting machines, dust collecting equipment.*

PARK CHEMICAL CORP., *(I-208). Buffing, polishing and heat-treating materials.*

PARKER-KALON CORP., *(I-211). Fastening devices.*

PARTLOW CORP., *(Combined Industrial Gas Exhibit). Temperature and time delay controllers, burner equipment.*

PITTSBURGH CRUCIBLE STEEL CO., *(N-322).*

PRODUCTION MACHINE CO., *(D-106). Polishing and finishing machines.*

PYRO-ELECTRO INSTRUMENT CO., *(E-128). Hardness testers.*

PYROMETER INSTRUMENT CO., *(J-331). Pyrometers, radiation tubes.*

RADIUM CHEMICAL CO., *(J-318). Films showing defects in parts.*

REPUBLIC STEEL CORP., *(C-131). Alloy and stainless steels.*

RESISTANCE WELDERS MFGRS. ASSOCIATION, *(A-137).*

RUSTLESS IRON & STEEL CORP., *(G-210). Data on the machining of stainless steel.*

JOSEPH T. RYERSON & SON, INC., *(N-313). Alloy steels.*

E. H. SARGENT & CO., *(L-318). Electrolytic analyzers, polarograph.*

SCULLY STEEL PRODUCTS CO., *(G-205).*

SELAS CO., *(Combined Industrial Gas Exhibit). Combustion controllers, burners, furnaces.*

SELLERS ENGINEERING CO., *(Combined Industrial Gas Exhibit).*

SENTRY CO., *(J-319). Electric hardening furnace, atmospheric control by diamond block method, high temperature tube combustion furnace.*

SLEEPER & HARTLEY, INC., *(D-105). Wire and spring machinery.*

SPENCER TURBINE CO., *(H-213). Turbocompressors, industrial vacuum cleaners.*

STANDARD STEEL SPRING CO., *(L-314). Corrosion proof coating.*

STEEL CITY TESTING LABORATORY, *(D-104). Laboratory apparatus.*

CHARLES G. STEVENS CO., *(L-303).*

N. A. STRAND & CO., *(A-115).*

D. A. STUART OIL CO., *(C-134). Cutting oils.*

SULMET ALLOYS CO., *(N-314). Secondary nickel.*

SURFACE COMBUSTION CORP., *(Combined Industrial Gas Exhibit). "Char-Mo" controlled atmosphere furnace.*

SYNTHANE CORP., *(Bakelite laminated products.*

C. J. TAGLIABUE MFG. CO., *(K-335). Indicating, recording and controlling instruments.*

TENNESSEE COAL, IRON & RY. CO., *(G-205).*

THERMEK CORP., *(M-334).*

HENRY G. THOMPSON & SON CO., *(B-131). Hacksaw blades.*

TIDE WATER ASSOCIATED OIL CO., *(B-129). Cutting oils.*

TIMKEN ROLLER BEARING CO., *(D-117). Stainless steels, aircraft steels, tool and die steels, corrosion resisting steels, seamless tubing.*

TINNERMAN STOVE & RANGE CO., *(F-207). Speed nuts and speed clips.*

TITANIUM ALLOY MFG. CO., *(K-310). Ferrous and nonferrous alloys of titanium and zirconium.*

UDDEHOLM CO. OF AMERICA, *(B-134). Tool steels, hobbing iron.*

UNA WELDING, INC., *(B-111). Automatic and semi-automatic welding heads, welding electrodes.*

UNION CARBIDE & CARBON CORP., *(L-301). Welding and cutting equipment, alloys for special applications.*

UNITED STATES STEEL CORP., *(G-205). Joint display of the products and facilities of U. S. Steel Corp. subsidiaries.*

UNIVERSAL-CYCLOPS STEEL CORP., *(K-321). Tool, stainless and specialty steels.*

VANADIUM-ALLOYS STEEL CO., *(A-125). Tool steels.*

VANADIUM CORP. OF AMERICA, *(E-103). Vanadium alloys.*

VICTOR SAW WORKS, INC., *(M-328). Hacksaw blades.*

VONNEGUT MOULDER CORP., *(H-209).*

VULCAN COPPER & SUPPLY CO., *(A-107).*

VULCAN CRUCIBLE STEEL CO., *(J-316). Forgings, tools and special steels.*

WALL COLMONOY CORP., *(M-327). Hard surfacing materials.*

WESTINGHOUSE ELECTRIC & MFG. CO., *(B-125). Electric furnace for bright-hardening tool steel, arc welders, welder controls.*

WHEELCO INSTRUMPNTS CO., *(J-332). Indicating and controlling instruments.*

WHEELOCK, LOVEJOY & CO., *(L-316). Parts and tools made from "Hy-Ten" and S. A. E. alloy steels.*

WILSON MECHANICAL INSTRUMENT CO., *(H-207). Hardness testers.*

WILSON WELDER & METALS CO., *(M-319). "Hornet" arc welders.*

WIRE ASSOCIATION, *(D-120). Educational exhibit.*

YOUNGSTOWN SHEET & TUBE CO., *(N-319). Alloy steels.*

CARL ZEISS, INC., *(G-208). Optical instruments and accessories.*

ZIV STEEL & WIRE CO., *(J-309). Tools and dies.*

SHOW IN PRINT

New and improved equipment, accessories and materials on display at the National Metal Show in Chicago, October 23-28

J. & L. "FLAME CONTROL" BESSEMER STEELS

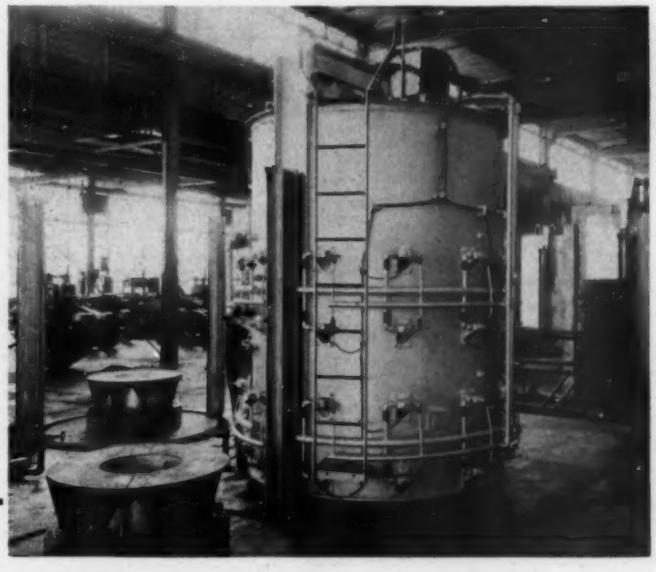
An exclusive method using an arrangement of photo-electric cells and other devices to provide accurate regulation of blowing conditions has been developed by Jones & Laughlin Steel Corp., Pittsburgh, Pa., in order to scientifically control the Bessemer process and so insure uniform quality. In the past, control of the Bessemer converter depended upon the skilled eyes of the blower, who had sole responsibility in determining the proper "end point" of the blow, which has a definite connection with quality results. The flame control supplements the skill of the human eye by a method which operates instantaneously. Records of heats blown are showing a narrowed range of temperature of the steel at the end of the blow, improvement in freedom from surface defects, sounder structure in the center of billets and bars, and a more even distribution of additions.

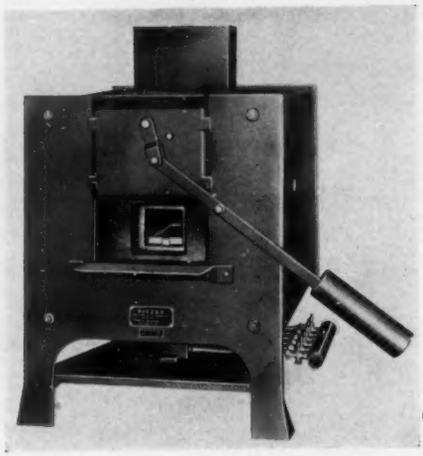
It is claimed that the gains of the past few years in improving the inherent machining qualities of Bessemer steels have been consolidated by this control, for with its use the quality obtained from heat to heat is reproduced between narrow limits. This results in a higher degree of satisfactory workability not only in machining, but in forming and fabricating operations as well. In general, good machinability means: the ease with which a chip may be removed, the ease with which a good finish is obtained, and finally the tendency of the material to abrade the tool. Steels produced by the Bessemer flame control method are claimed to show marked improvement in all three of these qualifications.

CONTINENTAL "TOP HAT" FURNACE

Developed especially to give temperature uniformity and provide high temperatures without resorting to the use of electrical energy, the "Top Hat" bell-type lifting cover furnace offered by Continental Industrial Engineers, Inc., 201 N. Wells St., Chicago, Ill., is available in a number of sizes. These furnaces provide a continuous radiant wall surrounding the material, with adjustments available to permit control of temperature and heat input at any horizontal plane. An internal central radiant burner is optional equipment for this furnace when used for annealing coiled strip or wire.

The burner permits a wide range of regulation; the "turn down" exceeds 15-to-1. All hot portions of the furnace are built from a special high-grade refractory to give long life under severe conditions. In order to start the furnace, it is merely necessary to close the electric plug connections and the flexible gas connections; then by closing a single starter switch, all burners are automatically lighted and the furnace is in operation. A full complement of safety devices is furnished, so that operation is entirely automatic.





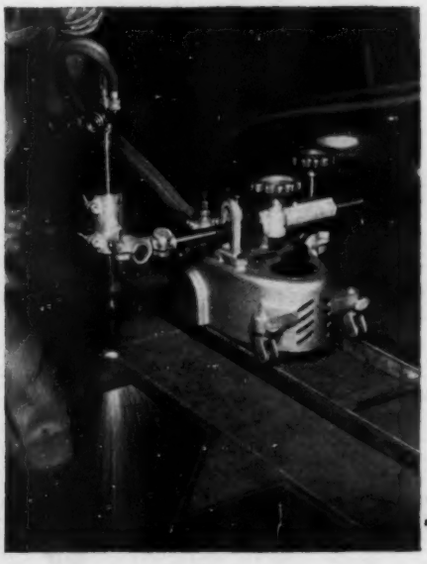
HONES "SUPER HEAT" FURNACES

The "Super Heat" high speed atmospheric oven furnaces developed by Charles A. Hones, Inc., Baldwin, L. I., N. Y., are designed primarily for heat-treating high carbon and alloy steels. A temperature of 2,400 F. is obtained without blowers or other auxiliary equipment. Only one connection to the gas supply is required. Maximum temperature is reached within 1½ hr. with manufactured gas at 3-in. pressure. Equipped with "buzzer" venturi nozzle burners, these furnaces have a wide range of control. The door is counterbalanced and the operating handle may be attached on either the right or left-hand side. A silicon-carbide muffle, rests on a hearth of the same material, thus preventing direct flame impingement. The full muffle design prevents flue gases from coming in contact with the work.

"CELECTRAY" SELF-BALANCING POTENTIOMETERS

A "Celectray' self-balancing type single-point indicating potentiometer controller and a multiple-point "Celectray" indicating potentiometer, also of the self-balancing type, have been developed by C. J. Tagliabue Mfg. Co., Park and Nostrand Aves., Brooklyn, N. Y. The self-balancing multiple-point indicator shown is supplied in three models. In these models the hair-line indicator is designed to cross 10-in. of scale in 10, 22, and 45 sec., respectively. The more rapid model is particularly suited for applications where a large number of temperatures are to be measured. The indicator will balance on successive points more rapidly than an operator can record them. An "in balance" signal light is provided which lights when the carriage travels from one point to the next, flickers when it steps into balance, and stays out when it is time to take the reading. Another feature is the arrangement for lighting the scale, this being accomplished through the use of a Lucite rod which carries the illumination from the same source of light that is used to determine the galvanometer position.

The single-point "Celectray" indicating potentiometer controller is designed to indicate temperature at all times on a 10-in. scale. The control point is adjusted by means of a knob. Like other models of the "Celectray" potentiometer line, this instrument uses a beam of light, a mirror galvanometer and a phototube, which eliminates the use of a complicated mechanical design. A Lucite rod also is used in this instrument for lighting the scale.

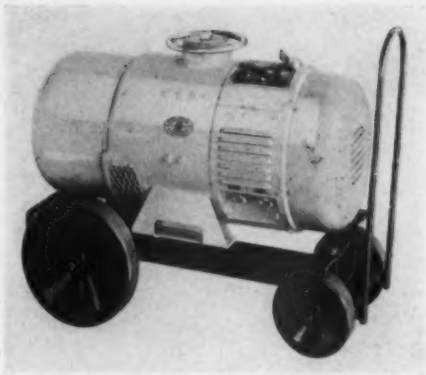


NATIONAL NO. 5 OXYACETYLENE CUTTER

Total weight of the No. 5 gas cutting machine offered by National Cylinder Gas Co., 205 W. Wacker Drive, Chicago, Ill., is only 35 lb. It can be moved from one job to another easily. This machine has a cutting speed range from 3½ to 50 in. per min., the speed control knob being placed on the top of the machine where adjustment of speeds when cutting will not disturb its operation in either direction. Reversal of the machine can be done without injury to the motor when the machine is traveling at any speed. Large handwheels located at the top of the unit permit the torch to be raised or lowered, or moved in or out. Torch holder can be adjusted angularly for bevel cutting. The hose manifold on the top of the unit relieves hose drag.

This oxy-acetylene cutting machine will cut straight lines of any length with either square or beveled edge. The machine runs on a light-weight section of track approximately 5 ft. in length. Two sections of track can be used progressively to make continuous straight line cuts. It will cut strips of steel plate from 2 to 30 in. in width. By using two torches, two cuts can be made simultaneuosly with the warpage of the plate held to a minimum. This procedure requires a long torch holder, an additional torch, torch holder and torch bar slide bracket. Circles from 3 to 89 in. in diameter can be cut.

WILSON "HORNET" ARC WELDER



The "Hornet" single-operator, motor-generator type arc welder announced by Wilson Welder & Metals Co., Inc., 60 E. 42d St., New York, N. Y., requires only one control device for operation. Adjustment of the single handwheel at the top of the unit permits the operator to obtain an infinite number of current settings. Dial markings are accurately calibrated and no meters are required. Single-pole control design is said to assure a current output that will not vary.

The "Hornet" welder is a two-bearing unit, with the motor rotor and generator armature mounted on a common shaft. Although shielded arc electrodes are recommended, this welder will operate with equal efficiency when bare electrodes are used. It is supplied in three sizes, with ratings of 200, 300, and 400 amp.

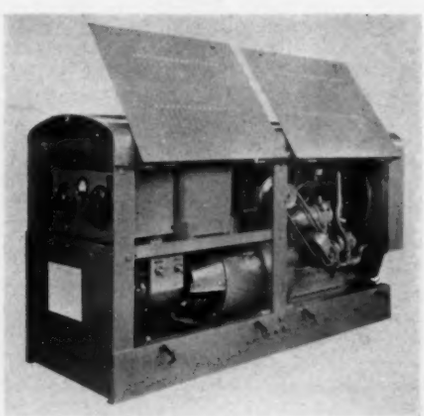
MUREX WELDING ELECTRODES

Metal & Thermit Corp., 120 Broadway, New York, N. Y., is announcing development of "Murex" Type FHP and stainless steel welding electrodes. Type FHP electrode is an all-mineral coated welding rod with the coating applied by extrusion under high pressure. It is used with either d.c. or a.c. and is designed for high speed, horizontal fillet welding of mild steel. It also is suitable for groove welding where the work can be positioned to permit all welding to be done downhand. Rate of deposit is high and deposits are smooth. Tensile strengths of stress-relieved welds made with Type FHP electrodes average from 63,000 to 68,000 lb. per sq. in., while ductilities of such welds range from 25 to 30 per cent elongation in 2 in. The "Murex" stainless steel electrode also has a coating extruded under high pressure. Weld metal deposited by this electrode has an analysis of 18 per cent chromium and 8 per cent nickel. Tensile strengths of welds range from 85,000 to 95,000 lb. per sq. in., while ductilities average 40 to 50 per cent.

HOBART "MULTI-RANGE" ARC WELDER

The improved "Multi-Range" arc welders offered by the Hobart Bros. Co., Box TA-69, Troy, Ohio, employ the same principles of control as were used in previous models, however the wide welding range of each machine is now divided into ten ranges with a 100-step, continuously-wound rheostat operating in each range. The result is said to be a complete absence of "dead spots", closer control of the relationship between open circuit voltage and welding current, and smooth operation. The "remote control" feature is retained in these welders. The rheostat is now located within the ten-range dial where it automatically plugs in or out when used on the machine or at any distance away. Only a lamp cord extension is required to place the rheostat convenient to the hand of the operator. These arc welders now are available in "Junior" models in 100, 150 and 200 amp. ratings. "Senior" models include 150, 200, 300, 400 and 600 amp. capacity units with electric or gasoline motor drives.

LINCOLN ARC WELDER DIESEL-ENGINE DRIVEN



A 300-amp. diesel engine driven arc welder, which is equipped with gasoline starting rather than the conventional motor starter with storage batteries, is offered by the Lincoln Electric Co., 12818 Coit Road, Cleveland, Ohio. The diesel engine which drives the welder compares favorably with gasoline engine in dependability of starting, simplicity, weight and cost, as well as in operating speed. The gasoline engine used for starting the welder is a small auxiliary unit mounted above the diesel engine. It is started by means of a hand crank. A belt drive connects the starting engine to the diesel which uses 1.5 gal. of fuel per hr. at full load.

The arc welding generator used on this welder is the 300-amp. "Shield Arc SAE" unit equipped with dual continuous control. By making possible the independent adjustment of both voltage and current, the dual continuous control provides the correct size and type of arc for all applications. Other features of this generator include: extra wide welding range; independent excitation; laminated magnetic circuit; high capacity; high efficiency; tool operation; and an all-purpose meter. Frame of the generator is attached directly to the diesel engine housing. The generator shaft is connected to the engine flywheel by a flexible coupling.

HARDY "POWDER-BRAZE"

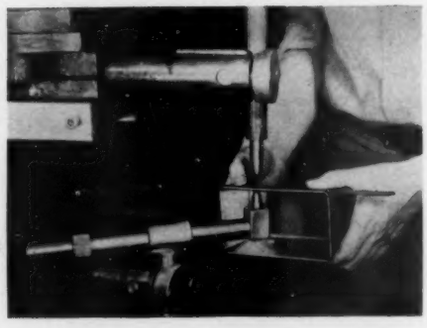
Charles Hardy, Inc., 415 Lexington Ave., New York, N. Y., has announced the development of a "Powder-Braze" brazing powder which is especially suitable for joining non-ferrous metals and alloys such as copper, bronze, and brass. The melting point is relatively low, temperature of application ranges from 1,325 to 1,450 F. The molten alloy flows freely and penetrates deeply, giving a tough, malleable joint. Powder braze is applied by heating the joint and permitting the powder to flow from the spouted can in which it is packed. In joining copper to copper no flux is required.

ANACONDA LOW-FUMING WELDING ROD

The Anaconda No. 997 welding rod announced by the American Brass Co., Waterbury, Conn., is recommended for general oxyacetylene welding. It is a high-strength, tough weld metal with low-fuming characteristics, and is used for general repairing of cast and malleable iron, steel and copper. This rod also is used with the oxyacetylene torch in building up corrosion resisting and wear resisting surfaces on valves, locomotive drive boxes and machine surfaces. In common with other bronze welding rods, this rod has a low melting point of 1,600 F., which makes it possible to repair-weld parts while they are still in place. In most cases, the parts to be repaired can be preheated in place with the use of an acetylene torch.

MALLORY UNIVERSAL TIP HOLDER

A universal offset water-cooled holder for spot-welding tips has been developed by P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind. This holder is easily adjustable to all positions required to reach inaccessible spots. It is assembled entirely of standard parts and is available with either a 30 or a 90-deg. tip socket. An important feature is a tip knock-out device which eliminates difficulties in removing tapered-shank tips.

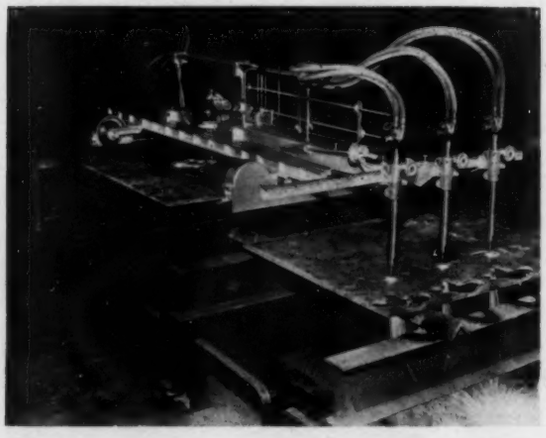


OXWELD CM-23 SHAPE-CUTTER

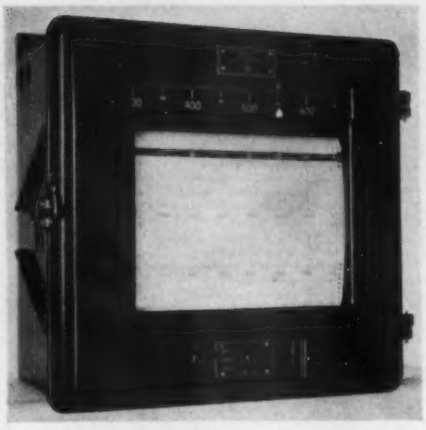
The "Oxweld" No. CM-23 stationary oxyacetylene shape cutting machine announced by the Linde Air Products Co., 30 E. 42nd St., New York, N. Y., is designed to cut irregular shapes, rings, circles and straight-line bevels, either automatically with templets or guided by hand direct from a full-scale drawing. It is available in two sizes, with cutting ranges of 54 and 81 in. in width by 12 ft. in length. The maximum cutting area is slightly less when the machine is used for hand tracing. Circles ranging in diameter from 6 to 49½ in. for the smaller machine, and 72 in. for the larger size, can be cut. Both sizes may be extended indefinitely longitudinally by the addition of 6 ft. lengths of machine legs, rails and work support. In addition, the machine can be supplied with a transverse capacity of 108 or 135 in.

This shape cutting machine is equipped to accommodate a three-hose cutting blowpipe, of either the low- or medium-pressure type. Multiple blowpipe mountings on the standard models permit simultaneous operation of as many as four blowpipes. Steel plate up to 12 in. thick can be cut.

The carriage is driven by a small, variable-speed electric motor. Speed can be varied from 3½ to 48½ in. per min. when templet tracing, and from 5½ to 82 in. per min. when hand tracing. The driving and tracing head is equipped with drive trunnions for automatic templet-tracing, but for hand tracing of any design or pattern where the machine is not to be used for repetitive cutting, the mechanical tracing unit can be detached and the line-tracer substituted in the offset position. Although the operating principles of the No. CM-23 machine remain the same as those of the No. CM-2, improvements in the design make for greater cutting precision, while other improvements are designed to simplify the duties of the operator.



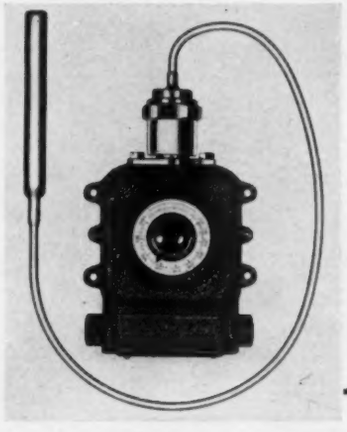
FOXBORO "STABILOG" CONTROLLER



In addition to a complete line of recording, controlling and portable pyrometers, the Foxboro Co., Foxboro, Mass., will exhibit an improved "Stabilog" potentiometer recorder-controller. This instrument is essentially a combination of the "Stabilog" control mechanism and the potentiometer recorder. It gives 100 per cent automatic continuous control without the necessity of auxiliary manual adjustment. Through a positive cam and follower assembly, changes in temperature are transmitted instantly to the control mechanism, where the necessary changes in valve settings are made.

HOUGHTON PERLITON NO. 45

Perliton No. 45 rapid liquid carburizer developed by E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa., is a unit product, not requiring the addition of carbon to the top of the bath. It is said to be at least 20 per cent faster in carbon penetration than the regular Perliton liquid carburizer which consists of a molten salt to which carbon is added. Perliton No. 45 is recommended for short heat on production runs where speed is essential.

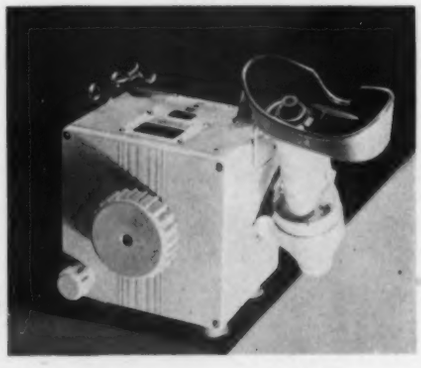


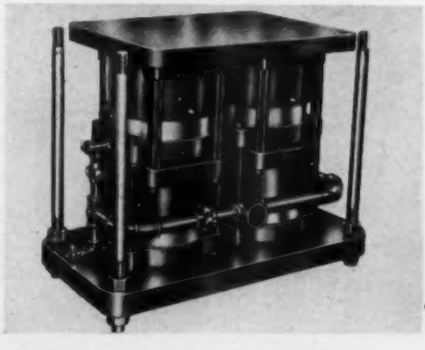
PARTLOW MODEL Z TEMPERATURE CONTROL

Available in both calibrated and uncalibrated types, the Model Z electric temperature control offered by The Partlow Corp., 2 Campion Road, New Hartford, N. Y., is used with motor operated or solenoid valves for controlling the flow of gas, oil or steam, or it may be used for controlling electric heating units, relays or starting and stopping motors. The calibrated type automatically will maintain the temperature which is set on the scale, this setting may be changed easily by turning the knurled knob on the front of the case. The uncalibrated type has a dial marked from 0 to 50, providing simple means of logging as in the case of a radio dial. Once the desired temperature is found, it may be duplicated indefinitely by setting the dial properly. Either two- or three-wire control circuits may be furnished by using one of three types of Micro switches. This control unit is 6 in. high and 3 in. deep. It uses the Partlow mercury-actuated flexible element.

L. & N. OPTICAL PYROMETER

A potentiometer-type optical pyrometer, in which both potentiometer and telescope are housed in light-weight alloy castings, is announced by Leeds and Northrup Co., 934 Stention Ave., Philadelphia, Pa. This is a direct-reading instrument showing temperature in degrees Fahrenheit on an openly-calibrated scale. Range is from 1,400 to 5,200 F. For measuring temperatures of molten metals, it contains an emissivity compensating screen which, when snapped into position, makes the instrument direct-reading for molten metals having emissivity of 0.4. To measure temperature, the operator has only to set the telescope and adjust the potentiometer.





HEAVY-DUTY PNEUMATIC DIE CUSHIONS

A double-unit, general utility pneumatic die cushion, designated as a "Double C" unit, has been added to its line of heavy-duty pneumatic die cushions by the Dayton Rogers Mfg. Co., 2830 S. 13th Ave., Minneapolis, Minn. This deep-draw unit has been designed primarily to fit large straight-side draw presses requiring draw ring holding pressures ranging from 10 to 45 tons, and a drawing capacity from 1 to 8 in. deep. This type of cushion may be mounted either directly to the bolster plate, or hung with suspension rods from the press frame. It is furnished with pneumatic regulator and gage, which automatically determines the air pressure used and maintains a predetermined constant pressure on the cushion cylinder.

FISHER LABORATORY BELT GRINDER

A belt grinder developed especially for use in the metallurgical laboratory has been made available by Fisher Scientific Co., 711-723 Forbes St., Pittsburgh, Pa. This grinder is fully inclosed and is driven by a ½-hp. motor. Specimens are held against the moving belt, which is supported by a machined surface plate. An open space at the top of the housing permits the operator to apply the specimen to the belt without danger of catching his clothing in moving parts. The housing can be lifted away from the unit to facilitate cleaning the machine and changing grinding belts. Belt tension is maintained by a weight operating on an eccentric shaft. Grinding belts are available with five grades of grit. The belts are 4 in. wide and are made with a 45-deg. seam.

CHASE TELLURIUM COPPERS

Two tellurium coppers have been made available by Chase Brass & Copper Co., Waterbury, Conn. Type A features a unique combination of conductivity, forgeability and machinability, while Type B tellurium copper combines hardenability, strength, forgeability and machinability. These combinations of properties render these alloys suitable for a number of classes of use.

Chase tellurium coppers are available in both rod and tube forms, while leaded copper, free-cutting commercial bronze, and leaded-silicon bronzes are available in rod form only. Both types of tellurium copper have good resistance to corrosion, season cracking, stress corrosion cracking and fire cracking.

Type A machines about 25 per cent faster than leaded copper or free cutting commercial bronze and about 50 per cent faster than leaded silicon bronze. The best temperature for hot working is not critical and may be within, or even beyond, the range of 1,200 to 1,600 F. Rate of cooling is not important. The alloy may be quenched, air cooled, or furnace cooled. It may be extensively cold-worked, although at room temperature it is somewhat less ductile than copper.

In general, Type B tellurium copper has the same advantages as Type A. The outstanding difference is that Type B has capacity for being strengthened and hardened by heat-treatment. Yield strength of Type B forgings can be increased from about 10,000 to 40,000 lb. per sq. in. by heat-treatment.

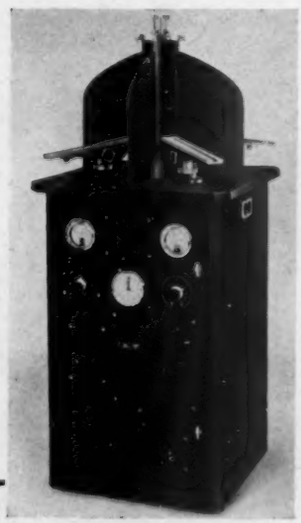
DETROIT BRINELL TESTER

A Brinell testing machine placed on the market by the Detroit Testing Machine Co., 5137 Trumbull Ave., Detroit, Mich., is especially suited for testing large and awkward parts, such as castings and forgings. This machine has a large stationary table and a ram sufficiently long to cover the range of the machine.

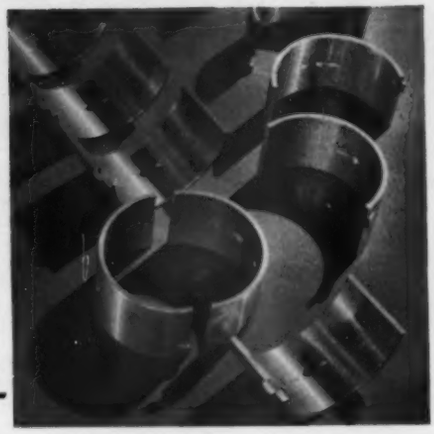
The work is simply placed on the table and the ram carrying the test ball brought into contact with it. Operation is controlled by a lever on the side of the machine, and the ram may be stopped in any position. Operation is hydraulic throughout. Two standard sizes are available. No. 1 has a throat depth of 6 in., maximum height of 12 in., and a 12x20 in. table. The No. 2 tester has a throat depth of 9 in., maximum height of 18 in., and a 17x24 in. table.

G. E. X-RAY DIFFRACTION UNIT

The "Hayes" X-ray diffraction unit offered by the General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill., embodies features which are claimed to satisfy the most rigorous specifications for precision research and control without sacrificing requirements for safety, simplicity, flexibility, ease of operation, and adaptability. The high-voltage transformer has a rating of 30 milliamperes at 60 kilovolts peak. The pinhole assembly and instrument supports are arranged to allow maximum convenience of adjustment and alignment of pinholes, specimens and cassettes with the X-ray beam. Four independently adjustable instrument tables are provided to allow the registration of four diffraction patterns simultaneously. Each instrument table is furnished with an instrument guide rail and adjustable pinhole assembly. Suitable locking devices provide for maintenance of perfect alignment. The pinhole and slit inserts are interchangeable in the pinhole supports and can be furnished with a wide range of defining pinhole and slit sizes. Several different cameras, cassettes and measuring devices are available for use with this diffraction unit. Each is constant in its characteristic.



ALUMINUM-ALLOY AUTOMOTIVE BEARINGS

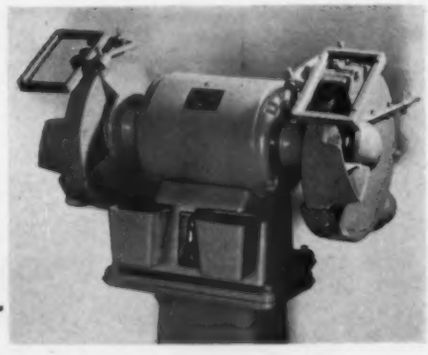


Development of an aluminum-alloy automotive bearing claimed to have long life, simple construction and high fatigue strength, has been announced by Aluminum Co. of America, Pittsburg, Pa. Advantages of these bearings are listed as follows: (1) a fatigue strength several times that of conventional bimetallic bearings used for the same purpose, (2) high resistance to corrosion by breakdown products of lubricating oils, and (3) economical construction because one metal does the job of two or more. For main and rod bearings, permanent mold castings are used, and rolled sheet is used for camshaft bearings. The main requirement is that it be properly made of the correct alloy with a thickness of at least 0.09 in.

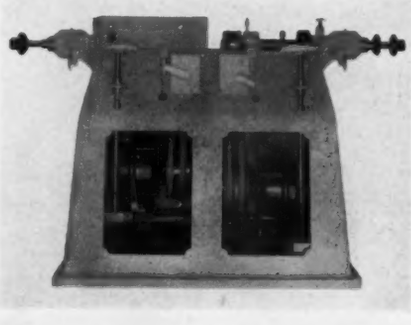
DURALOY CAST SCREW CONVEYOR

A centrifugally cast screw conveyor of one-piece design has been developed by the Duraloy Co., Scottdale, Pa. These conveyor screws are available in all the commercial chrome iron and chrome nickel alloys, including the stainless steel alloys. The flight is an integral part of the conveyor, being cast around a thick wall tube. The centrifugal process is claimed to insure a sound, homogeneous casting. Another advantage claimed is that the welding required when the flight is made separately from the inside shaft is not used in making these screws. Units can be made in several diameters and lengths.

BUEHLER SPECIMEN GRINDER



The No. 1210 water-cooled, two-wheel specimen grinder, offered by Adolph I. Buehler, 228 N. La Salle St., Chicago, Ill., is powered with a ¾ hp. motor which drives the two 12-in. grinding wheels at 1,750 r.p.m. Two water jets apply a stream across the face of each wheel. An appropriate guard is provided to prevent splashing and to protect the operator. The grinding of metallurgical specimens is accomplished without raising the surface temperature which might result in changes in grain structure. Grinding usually is done on the side of the wheel and the wheel is kept free from loading.



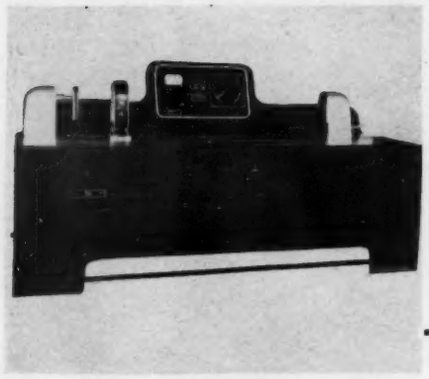
VARIABLE SPEED POLISHING LATHE

The No. 18 variable-speed polishing lathe offered by Chas. F. L'Hommedieu & Sons Co., 4521 Ogden Ave., Chicago, Ill., permits using 10 or 12 in. buffs at the same peripheral speed as a 16 in. buff. Speed control is by adjustable pitch V-belt sheaves on the individual motors driving each spindle. Adjustment is by hand wheel conveniently located at the rear of each head. A speed indicator is mounted beside each of the two speed control hand wheels. Spindle speeds can be varied between 1,700 and 3,000 r.p.m. Individual electrical controls are provided for each of the two motors.

MOORE 10-IN. ROTARY TABLE

An improved 10-in. diameter rotary precision table for use in connection with the Moore jig borer is offered by Marburg Bros., Inc., 90 W. St., New York, N. Y., sole distributor for the Moore Special Tool Co., Inc., Bridgeport, Conn. This table now is equipped with a sliding vernier plate adjustable to 1½ deg. toward both sides of the zero position. This facilitates setting the work either parallel or at right angles to the graduation. An improved graduation method has been applied to these tables, with the hairlines now as fine as 0.0025 in. and accurate to ±2 sec. of arc. Thus, holes can be quickly located within 0.0002 in. on a 10-in. circle in conjunction with the combined swiveling and micro adjustment, and the adjustable vernier plate.

IMPROVED MAGNAFLUX UNITS



The Magnaflux Corp., 605 W. Washington St., Chicago, Ill., has made available two improved magnetizing units, both transformer operated. Both units provide means whereby parts may be magnetized and demagnetized. The improved Type DT unit shown will handle parts up to 72 in. long, and is used in both the aircraft and automotive industries. It is constructed so that the wet method of inspection can be applied while the magnetizing current is on and the part is in the machine. The detection liquid is flowed over the part by means of a nozzle connected to a tank and pump which are integral parts of the unit. The smaller Type TF-203 unit is designed for parts not exceeding 20 in. in length. It functions similarly to the Type DT unit, except that the coil serves as a demagnetizer and the tank and pump features are not included. This unit is adapted for inspecting tools and small parts.

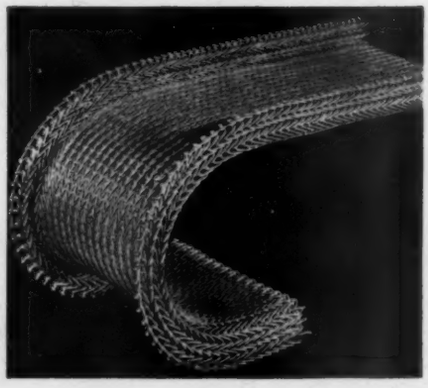
BLAKESLEE TYPE LLV DEGREASER

Equipped with dual control for degreasing metal parts prior to plating, finishing, assembly or inspection, the three-tank Type LLV degreaser offered by G. S. Blakeslee & Co., 19th St. & 52nd Ave., Cicero Station, Chicago, Ill., is said to require less than one minute to thoroughly clean and dry miscellaneous parts. Features of this degreaser include an improved water separator, steam coils mounted on the cleanout door, and heating facilities in each compartment for solvent distillation. This type of degreasing machine can be made in various sizes to suit individual requirements.

SARGENT ELECTROLYTIC ANALYZER

E. H. Sargent & Co., 155-165 E. Superior St., Chicago, Ill., offers an electrolytic analyzer designed to facilitate routine tests in laboratories required to produce a large daily volume of electrolytic analyses. It is claimed that by using this analyzer the time formerly required to perform many analyses can be reduced by as much as 60 per cent. It operates with higher current densities and uses larger electrode areas than has been customary, reducing the time required for complete deposition proportionately. Mechanical stirring mechanisms are not used, the electrolyte being thoroughly agitated electromagnetically. Electrode mounts are fitted with heavy Bakelite heads containing platinum gripping bases for the electrodes. This mount is vertically adjustable by a single motion of the hand, the electrodes being maintained in alignment by means of a ball-in-groove mechanism. Adjustment for alignment and depth of immersion are entirely automatic. Water cooling is incorporated as an automatic feature. The control panel and circuit are designed for currents as high as 10 amp.

AUBUDON CORD-TYPE WIRE BELT



The Audubon Wire Cloth Corp., Richmond St. and Castor Ave., Philadelphia, Pa., has announced development of a "Cord" type flexible "Metalwove" conveyor and processing belt. The construction of this belt permits openings smaller than the wire from which the belt is made. In addition, the construction permits higher flanging than heretofore permissible. It can be flanged and successfully operated without strain on the flanged edges to heights of 17 per cent of the diameter of the pulley over which the belt operates. Heretofore, flexible wire belts with flanged edges were limited to 3 per cent of the diameter of the pulleys. This belt is claimed to be true tracking and to permit operation under high working stress. When operated in high temperature bright hardening furnaces, the construction prevents freezing of small parts to the belt commonly found in some belt constructions.

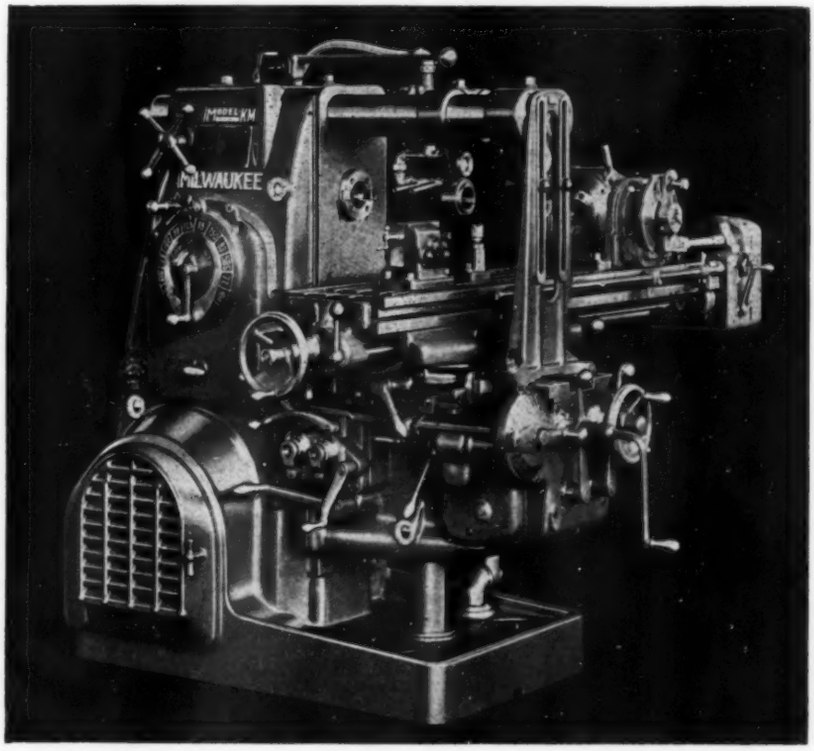
SHOP EQUIPMENT NEWS

Medium-Speed Millers Offered by K & T In Plain, Universal and Vertical Types

In order to more fully cover the precision heavy-duty milling field, the Kearney & Trecker Corp., Milwaukee, Wis., has introduced a medium-speed Model K machine listed as the Type KM, and available in No. 2 and No. 3 sizes in plain, universal and vertical types. The No. 3 KM universal miller shown is equipped with a spiral dividing head and low-lead attachment.

This line of medium-speed millers embodies all of the features incorporated in standard Model K machines, including duplicate front and rear controls, safety positive interlocks, single lever continuous series feed selection, solid back column, cross-mounted motor, center bearing spindle mounting, automatic pump lubrication and double overarms. These Model K machines have sixteen speeds in geometric progression with no overlapping. The speed range is from 15 to 750 r.p.m. Speed selection is made by two lever movements.

Sixteen feed changes in a continuous series, single lever operated, range from ½ to 30 in. per min. for table and saddle movements, and ¼ to 15 in. per min. for vertical knee and head movement. Single lever, finger-tip controlled rapid traverse in all directions provides 150 in. per movement for table and saddle, and 75 in. per min. for knee and vertical head. The rapid traverse is available at all times, whether the spindle is stopped or running.



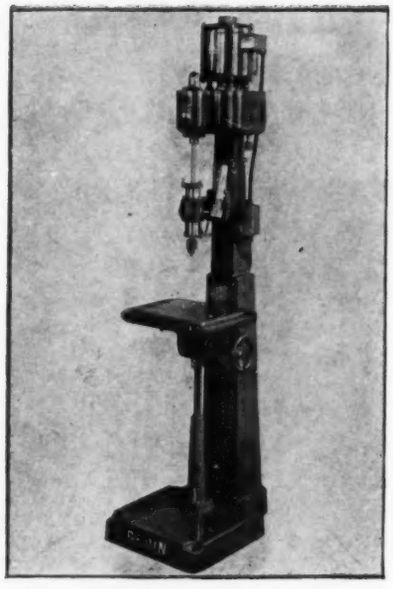
Manufacturing-Type Drill Has Adjustable Head

Among the machines which were to be exhibited at the Machine Tool Show was this No. 16-M manufacturing-type drill made by Buffalo Forge Co., 448 Broadway, Buffalo, N. Y. In this machine, the working surface of the table is kept at a constant height, convenient to the operator, and the head is quickly adjustable to give the desired height from the table to the drill point. The rack pinion which moves the head is operated by a crank at the side.

The table base measures 18 x 22 in., and has a 14 x 14 in. working surface. Five spindle speeds are available by shifting the V-belt on the stepped sheaves, which are dynamically balanced. These drills are available with one, two, three or four spindles, the center distance between spindles being 12 in. for the multiple spindle unit. Feed travel is 4 in. and the maximum distance from the chuck nose to the base is 14 in. Capacity of these drills is ½ in. in cast iron. Net weight of a single spindle unit is 182 lb.

"Redin" Drill Designed For High Production

Intended for high-speed production work, as well as toolroom use, the "Redin" No. 0 sensitive floor-type drill has capacity for drilling holes up to $\frac{5}{16}$ in. in diameter. This machine is driven through a "rolling wedge" four-speed transmission, which automatically adjusts pressure to the re-



sistance encountered and minimizes wear. Machine is equipped with New Departure grease-sealed ball bearings.

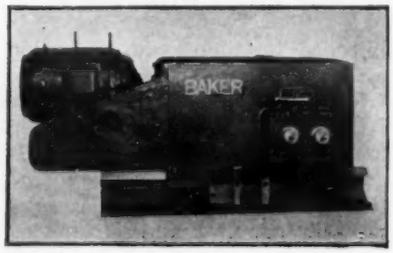
Spindle travel is 3⅜ in. and the distance from the spindle to the column is 6½ in. Minimum distance between table and chuck is 2 in.; maximum is 20 in. Motor delivers ½ hp. at 1,725 r.p.m., giving spindle speeds of 900, 1,800, 3,300 and 5,000 r.p.m. Sliding table traverse is 13 in.; that of the sliding head is 5¼ in. Table measures 10 x 12 in.

Baker Drill Unit Mounts at Any Angle

Developed to provide maximum flexibility for many different applications, the Model No. 5 x 12 self-contained drill unit offered by Baker Bros., Inc., Westlake and Post Sts., Toledo, Ohio, can be mounted vertically, horizontally or at any angle. It can be used for single spindle and multiple spindle drilling, boring, reaming, counterboring, hollow-milling, chamfering and facing operations. Machine is powered by either a 3- or a 5-hp. motor operating at 1,200 r.p.m., or by a 7½-hp., 1,800 r.p.m. motor.

Two types of mounting are available, with the motor driving the spindle either directly or through multiple V belts. Power for the hydraulic feed is obtained through a variable-delivery pump driven by the spindle drive motor. Unit is furnished with a two-feed cycle as standard equipment, and is also available with positive stops and delayed reverse.

Specifications: Maximum head travel, 12 in.; length of saddle, 26 in.; width of bed ways, 9 in.; distance from top of slide to center line of driving spindle for multiple heads, 7¼ in.; size of multiple head flange, 13 x 14 in.; driver speed range for multiple spindle use, 400-1,200 r.p.m.; rapid traverse speed, 174 in. per min. forward, 232 in. per min. return; spindle speed range in extension for single spindle operations, 200-500 r.p.m.; over-all length, 62 in. with direct-coupled motor drive.



Two-Lap Type Michigan Gear Lappers Designed for Production of Small Gears

Announced by Michigan Tool Co., 7171 E. McNichols Road, Detroit, Mich., a line of two-lap type gear lappers employing the crossed-axis method of operation has been especially designed for high production lapping of gears from ½- to 8-in. diameter. Automatic in operation, these machines are available in both vertical No. 994, Fig. 1, and horizontal No. 995, Fig. 2, types. Electrical controls are provided to permit adjustment of

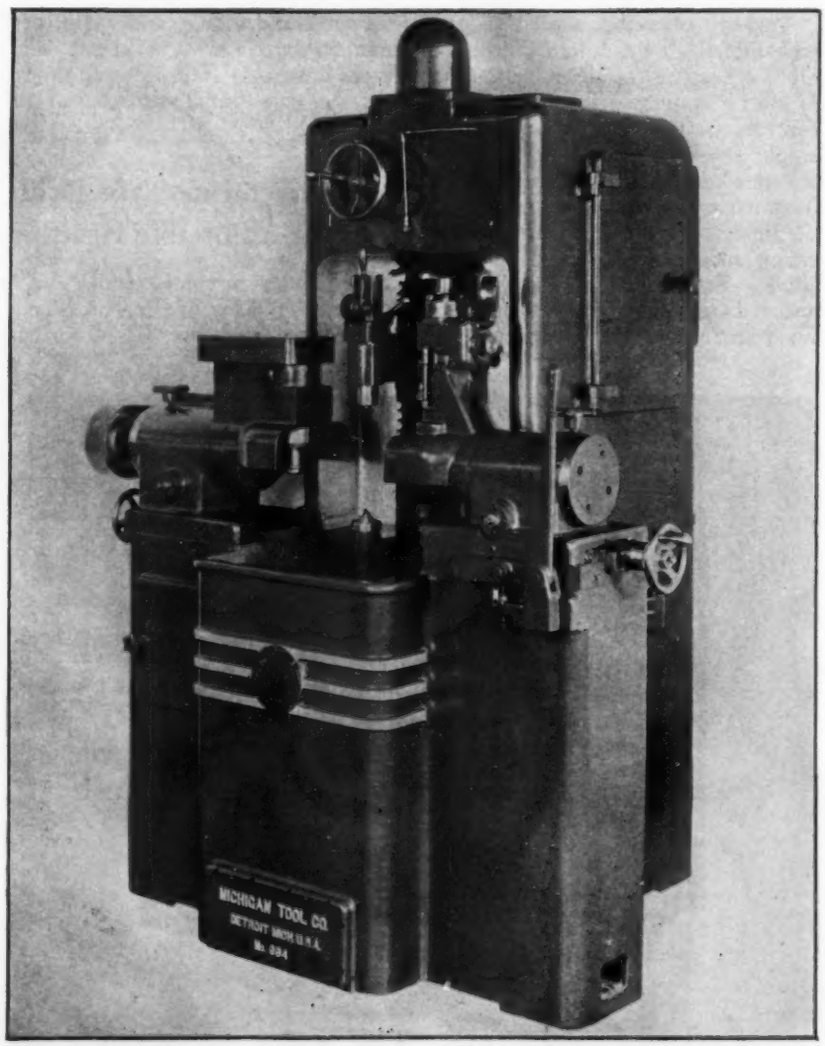


Fig. 1—Work may be oscillated at rates up to 300 strokes per minute in the Michigan No. 994 horizontal two-lap crossed-axis gear lapper. Capacity of the machine ranges from ½- to 8-in. diameter gears

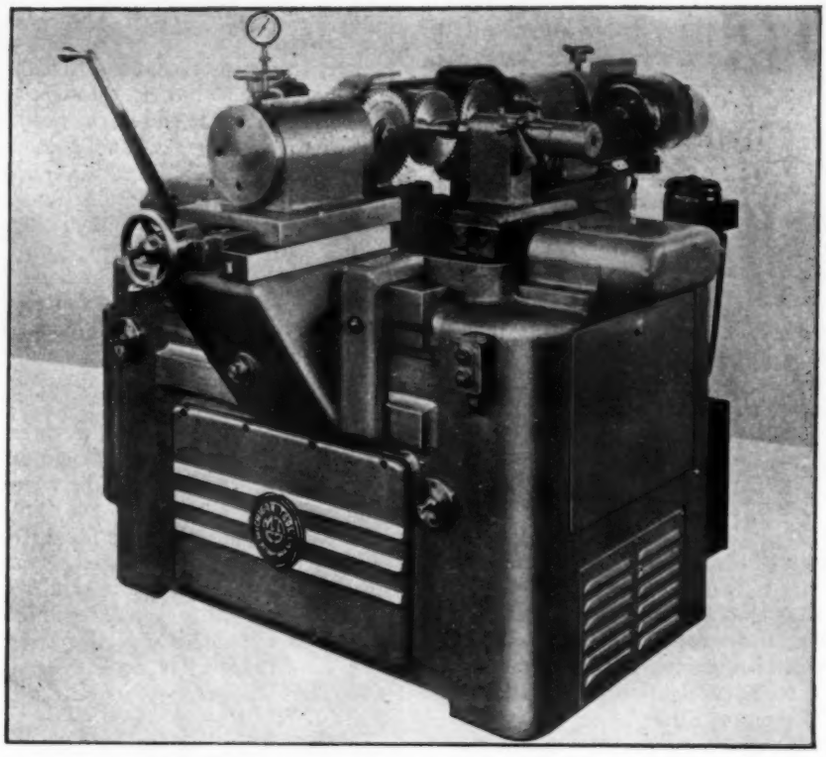


Fig. 2—Having the same features as the horizontal gear lapper, the Michigan two-lap vertical gear lapper is equipped with electrical controls providing full automatic operation

the lapping cycle to achieve virtually every possible variation desired.

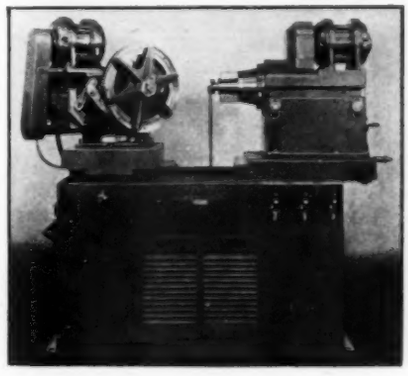
These machines employ a relatively low surface speed with a high speed of reciprocation of the laps across the gear faces. A single adjustment makes it possible to vary the number of these reciprocations from 90 to 300 per min. Lap spindle is driven through a change-gear box providing speeds ranging from 52 to 283 r.p.m. A third adjustment changes the length of the stroke, while two separate timers permit individual adjustment of lapping time on either side of the tooth, the range available being from 2 sec. to 20 min. in both directions.

In operation, the two laps are mounted on the lap spindles and the gear mounted between live centers between the laps. Lap spindle heads are then adjusted to provide the correct amount of crossed axis. A motor drives one lap spindle, the lap drives the work, and the work in turn drives the second lap, the spindle of which is equipped with a hydraulic brake. Through an eccentric drive, another motor rapidly oscillates the work-carrying head in line with the gear axis.

Lap spindle heads are provided with individual screw adjustments. Movable spindle is provided with adjustable stops to insure correct lap depth with reference to the work. Lapping compound is supplied by a special pump. Lubrication is through a manifold oiler. Particular attention has been paid to protection of bearings and other vital parts against dust and lapping grit.

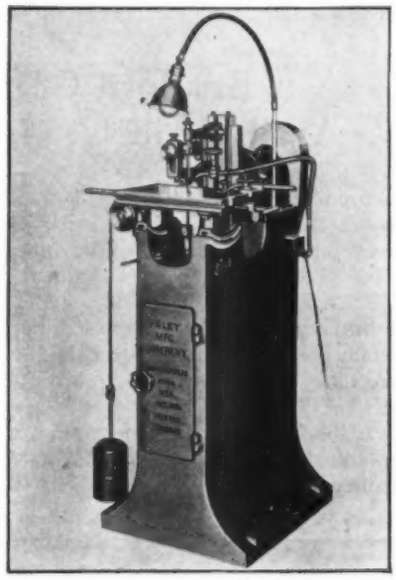
Chamfering Machine Uses Hollow Mills

The No. 106-A universal hollow mill gear chamfering machine recently announced and marketed by the Cimatool Co., 1517–1531 E. Third St., Dayton, Ohio, carriers one work head and one cutter spindle for hollow mill chamfering. In common with other units of this line, the workhead is presented to the cutter, the spindle of which remains in a fixed position. As the workhead moves away from the cutter after one pair of teeth has been chamfered, a finger indexing lever turns the gear just far enough to present the next two teeth. As the workhead returns to the cutter, a wedge engages the teeth to accurately position the gear before the next cut is taken. Thus minor inaccuracies in the spacing of the gear teeth do not materially affect the accuracy of the chamfer.



Foley Die-Maker Has Tilting Table

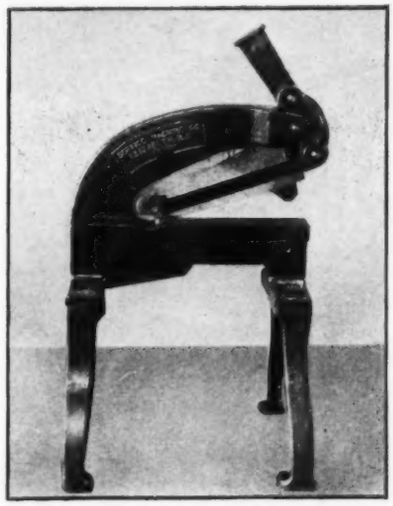
Sawing and filing of intricate die sections to close limits are possible on the improved die-making machine offered by the Foley Mfg. Co., 11-15 Maine St., Minneapolis, Minn. Pivotal center of both table and ram tilting is at the surface of the table, enabling cuts to be made at any angle without enlarging the hole. The ram can be tilted up to 20 deg. right or left, and the table tilts up to 20 deg. to the front, or 10 deg. backward.



The machine is equipped to saw all tool steels, including the high chrome high carbon steels. Saws as small as $\frac{1}{16}$-in. are available. Capacity of the machine is such that it will saw to the center of a 12$\frac{3}{4}$-in. diameter piece. Material up to 3 in. thick may be sawed or filed. All types of files, whether standard or special, including the smallest needle files, may be used. The ram is counter-balanced in the gear box to reduce vibration to a minimum. Four ram speeds are pro-

vided by step pulleys. These are 85, 125, 173 and 234 r.p.m.

One of the principal features of this machine is the universal feed guide. Forward tension on the feed is provided by weights, while a steering block enables the operator to feed the work at right angles to the feed tension, providing positive contour control on curved or irregular sections. The machine is powered with a ¼ hp. motor. One of the hold-downs is equipped with a nozzle so that a blast of air can keep the work clean.



Hand-Slitting Shear Cuts No. 10 Gage Steel

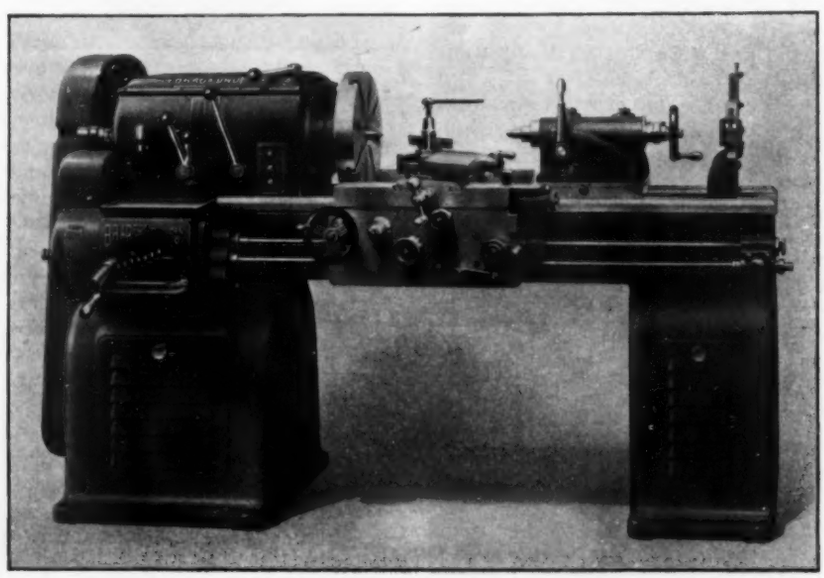
Listed as the "Semco" No. 16, a hand-slitting shear for use on No. 10 gage sheet steel has been added to the line of utility equipment manufactured by the Service Machine Co., 752 Broadway, Elizabeth, N. J. Corrugated or special shapes of sheet metal, such as flashing, can be cut by substituting special blades for those regularly provided. Standard blades are made of high-chrome steel to insure long service, and are jig-drilled to be readily interchangeable. Length of the blade is 16 in. Weight of the complete unit is about 475 lb.

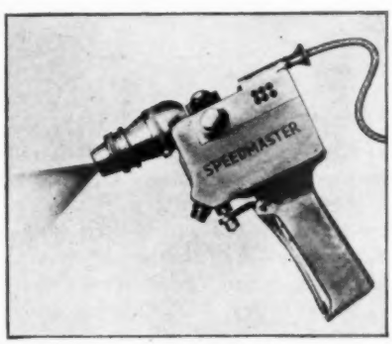
Bradford Geared-Head Lathes Available in 12, 14, and 16-in. Capacities

Geared-head lathes in 12-, 14- and 16-in. capacities of improved design are offered by the Bradford Machine Tool Co., 657 Evans St., Cincinnati, Ohio. Preloaded heavy-duty taper roller bearings support the spindle, while precision taper roller bearings are used throughout for all rotating shafts. Twelve selective speeds are available in geometric ratio from 16 to 400 r.p.m. Speed changes are controlled by three conveniently located levers which slide the headstock gears on splined shafts. The drive from the constant speed motor in the leg is through multiple V-belts and a multi-disk clutch. A multi-disk brake is used for stopping the spindle quickly. Motor control is effected by push buttons located at the front of the head within easy reach of the operator.

The lead screw and feed rod are driven from the spindle through feed reverse gears operated inside the head at the drive end. These are locked in the selected position by a spring plunger in the shift handle. Drive to the quick-change box is through a quadrant gear at the end of the head. Ordinary change gears can be used between the lead screw and the spindle for cutting special threads. Rotation of the lead screw is required only for screw cutting. An automatic stop is provided for feeds and a separate reverse for the feeds is provided in the lathe apron. These lathes can be provided with a taper turning attachment, draw-in collets, and an oil pump and pan.

Specifications: Each of the three sizes is available with a bed length of 6 ft. and will take 30 in. between centers. Swing-over bed is 14½, 16½ and 18½ in., respectively, for the three sizes. Range of threads for the two smaller sizes is 2 to 56 per in., and 1½ to 46 per in. for the 16-in. size. Net weight of the three respective sizes with a 6-ft. bed is 2,800, 3,100 and 3,500 lb. Longer bed lengths are available for all three sizes.

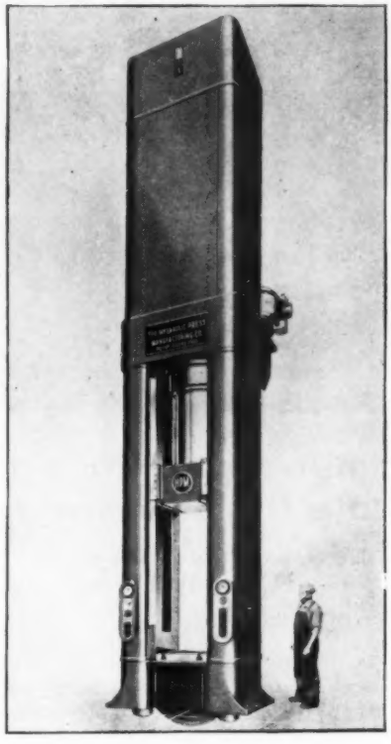




Metal Spray Gun Has High Capacity

Designed to spray efficiently all metals which can be obtained in wire or rod form, the "Speedmaster" metal spray gun offered by the Master Metal Spray Co., 2527 Magnolia St., Oakland, Calif., has extra-heavy bronze gears and all shafts mounted in self-lubricated ball bearings. Valves of the poppet type completely segregating the gases, are synchronized to operate by movement of a single lever. Rugged one-piece wire nozzle has but one gas joint. Power is provided by an impulse type turbine having a throttle control for variable speed range. Complete wire feed mechanism is removable from the casing in one unit for inspection. Capacities of the gun, in pounds of metal per hour, are: Aluminum, 8; steels, 9; bronze and copper, 20; zinc, 40; and lead, 80.

"Fastraverse" Press Designed Especially For Manufacture of Artillery Shells



The Hydraulic Press Mfg. Co., Mt. Gilead, Ohio, has developed a H-P-M "Fastraverse" drawing and tapering press to meet modern high-speed production requirements in the manufacture of artillery shells. This press is of the self-contained type with hydraulic pressure being delivered by a "Hydro-Power" variable-delivery type pump which is part of the closed circuit hydraulic operating system. Smooth operation and shockless reversal are accomplished by reversal of the pump instead of by manipulation of intermediate valves.

Rapid ram advance and return is accomplished by "Fastraverse" design which permits the free flow of oil between the main cylinder and the overhead oil supply tank. As the power unit is mounted on a bracket securely fastened to the press head, no obstructive piping or power unit equipment is located around the base of the press, resulting in a design which requires a minimum of floor space for installation.

Shell tapering presses are equipped with a mechanical ejector mechanism located beneath the press bed. Drawing presses are designed with a hole in the center of the press bed, through which the drawn shell is pushed and stripped from the punch. Pressing surfaces of the unit shown are 30 x 30 in. Maximum daylight opening between slide and bed is 132 in., and maximum ram travel is 120 in.

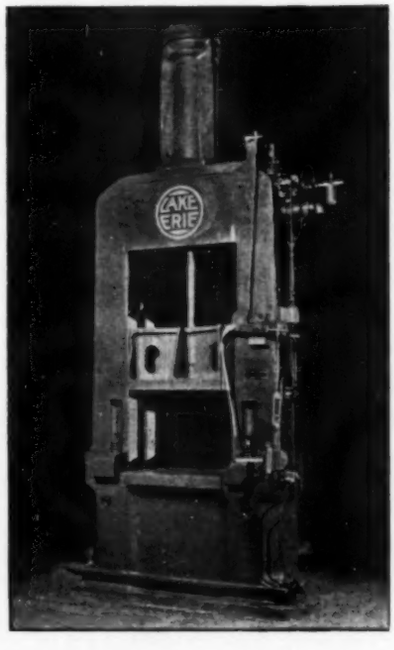
air cushion on top of the cylinder. Cast steel ram has been specially designed to withstand the most severe operating impacts. Anvil is cast of a tough alloy iron. Automatic air lubrication is included.

Daylight dimensions of the five models range from 36 to 60 in., while clearance between guides ranges from 30 to 96 in. Over-all dimensions range from 27 x 62 x 162 in. to 60 x 153 x 237 in. All models are completely self-contained, ready to connect to the compressed air line.

Air-Operated Stamps Run at High Speeds

Available in five models, a line of air-operated drop stamps announced by the Lake Erie Engineering Corp., 268 Perry St., Buffalo, N. Y., has been designed to operate at high speeds to provide maximum efficiency on either long or short runs. These units are suitable for stamping, forming and embossing standard or difficult-to-form alloys and thin, quick-cooling hot work. They also have many applications in general sheet metal working as well as in specialized fields such as the airplane industry where the character of alloys handled and the type of product necessitate this type of machine.

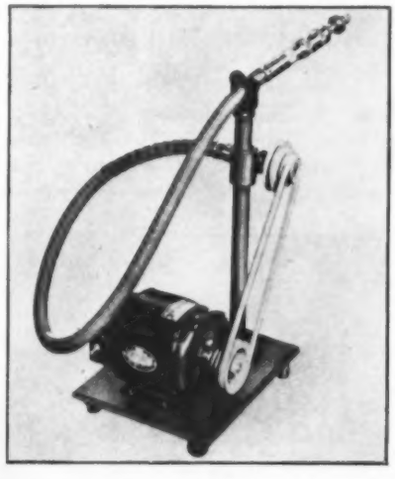
Sensitive control of speed and power are provided by a hand lever. Cam setting is adjustable for positive or oscillating motion. Safety is achieved by holding the ram in two upper positions by gravity-drop safety dogs. Over-travel is prevented by an



Flexible Shaft Machine Has Three Speeds

Stow Mfg. Co., Binghamton, N. Y. has added a multi-speed flexible shaft machine to its "Junior" line. Receiving its power from any light socket, this machine is suitable for such operations as grinding, drilling, polishing, wire scratch-brush work and other similar applications.

The unit is available with either a



$\frac{1}{4}$- or $\frac{1}{3}$-hp. motor. It has a speed range of 875–3,500 r.p.m., achieved through the use of three-step cone pulleys and V-belts. Maximum wheel capacity is 6 x 1 in. and maximum drill size is $\frac{3}{8}$ in. Handpiece is fitted with precision ball bearings.

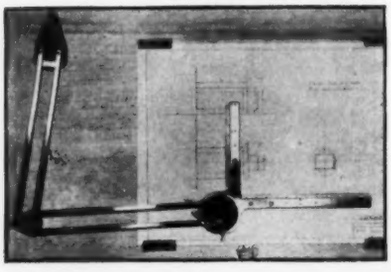
"Parab-O-Lume" Units Provide General Lighting

More and better light where needed is claimed to be distributed by the "Parab-O-Lume" ceiling reflectors made by the Berger Mfg. Div., Republic Steel Corp., Canton, Ohio, for use with indirect lighting units. Surface of the device, covered with alumi-

num paint, is made up of parabolic sections which reflect light downward with uniform distribution. Units are stamped from steel sheets and are available in standard sizes of 6 x 6, 8 x 8, 10 x 10 and 12 x 12 ft. They are easily installed with S-bars, screws or toggle bolts.

Drafting Machine Has Adjustable Ball Bearings

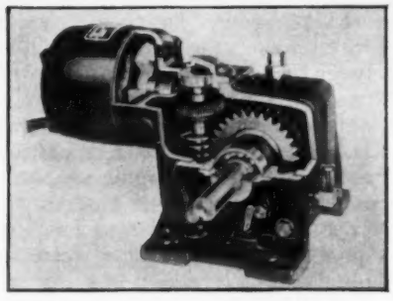
The Model D-520 "Wrigraph" drafting machine, developed by L. G. Wright, Inc., 5209-4 Euclid Ave., Cleveland, Ohio, is equipped with an adjustable ball bearing which is



claimed to increase the accurate life of the machine five times over previous models. Model shown will make drawings 20 x 26 in. or smaller, is furnished with a special tack-on mounting plate so that it can be instantly fastened in position on any flat wooden surface. Scales are interchangeable on the protractor head, and all standard graduations are available.

Speed Reducer Motor Develops High Torque

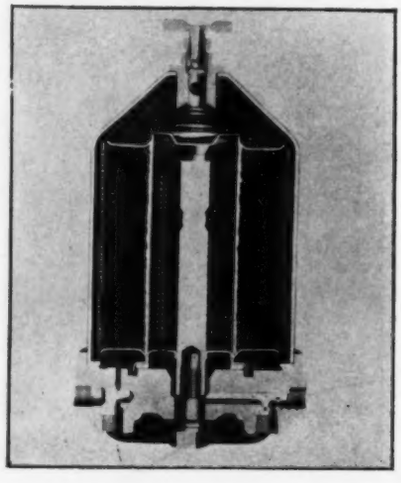
Providing a combination of speeds and torques not heretofore available, the Group 6, Series N-30RJ speed reducer motors offered by the Bodine Electric Co., 2264 W. Ohio St., Chicago, Ill., has been designed primarily for very low speeds and high torques. Units can be furnished for floor, ceiling, wall and flange mounting, with either vertical or horizontal drive shaft. Gear housing is cast integral with motor end shield. Primary gear is made of Bakelite to assure quietness, and secondary gear is machined of hard bronze to provide long life. Ball bearings, which are used throughout, take end thrust in both directions, so that the unit is reversible. Reduction ratios range from 72:1 to



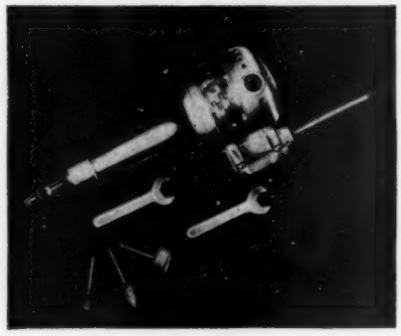
2,880:1. These Group 6 motors deliver speeds as low as 0.6 r.p.m. at torques as high as 350 in.-lb. Output ranges from 1/50 to 1/20 hp., depending on the gear ratio.

Oil Filter Protects Machine Tool Bearings

For the protection of bearings used on grinders, automatic screw machines and other machine tools, the Type T-1 oil filter has been put into production by the A. C. Spark Plug Div., General Motors Corp., Flint, Mich. Installed between the oil pump and the bearings, it removes all solid impurities such as fine metal chips. The filter is provided with a drain



cock which can be periodically opened to remove excess dirt in the case. When the element is filled with abrasives and other foreign matter taken from the oil, a replacement element can be installed in a few minutes.

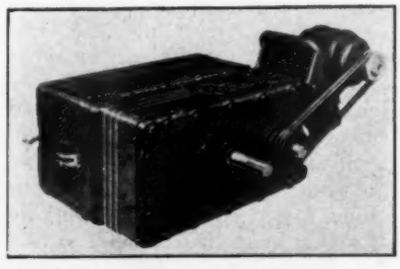


High Speed Die Grinder Has Overload Protection

Built-in protection against overload is provided in the Type O high-speed, ball-bearing die grinder offered by the James Clark, Jr. Electric Co., 600-640 E. Bergman St., Louisville, Ky. Protecting fuses have a one-minute time lag to eliminate blowing out or momentary overloads. No load speed of 20,000 r.p.m. is developed and wheels up to 1 x $\frac{3}{4}$ in. in size may be used. Over-all length is $10\frac{7}{8}$ in., and net weight is $4\frac{1}{2}$ lb. Motor operates on either a.c. or d.c., 110 volts.

"Multi-Ratio" Unit Is Infinitely Variable

Development of a "Multi-Ratio" drive unit combining an infinitely variable speed transmission with a conven-



tional speed reducer gearing to provide high load capacity with infinitely variable speed control has been announced by Mechanical Handling Systems, Inc., 4700 Nancy Ave., Detroit, Mich. With capacities up to 80,000 lb. torque and infinitely variable speed ranges of from 310 r.p.m. forward to —9 r.p.m. reverse, this drive unit is available either for right-

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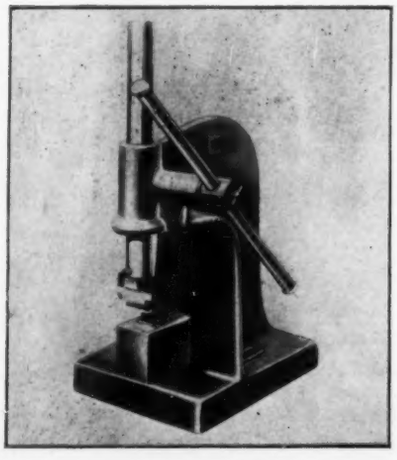
or left-hand installation and with either vertical or horizontal output shaft. Two basic units, identical in design except for capacity, are available. In the larger capacities, the output shaft is vertical and may be had either upward or downward, short or extended, the latter style employing an outboard bearing.

Complete Marking Outfit Offered by Bates

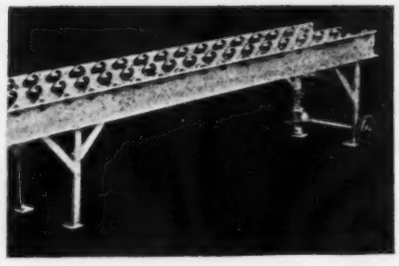
A combination arbor press and "Hercules" type holder, complete with type and necessary fixtures for stamping nameplates or other parts, has been made available by H. O. Bates, 251-257 N. Broad St., Elizabeth, N. J. Arbor press has a square



ram for accuracy parallel line stamping. Characters are easily changed by simple pressure on a thumb clip. Since the arbor press has a leverage ratio of 50 to 1, it is suitable for stamping up to eight ⅛-in. figures in stainless steel or four times that number in aluminum. The anvil block has a pin adjustment for line spacing.

Portable Conveyor Has Ball-Bearing Wheels

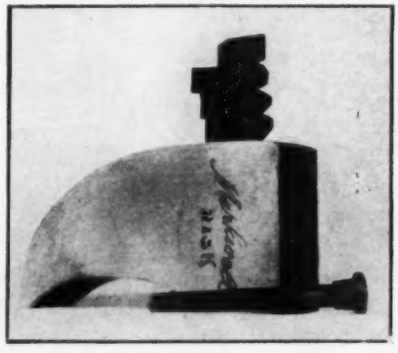
Combining high strength with light weight, a roller type portable conveyor made of 61ST "Alcoa" aluminum manufactured by the Aluminum Ladder Co., 104 Adams St., Tarentum, Pa., is fitted with steel ball-bearing wheels mounted on eccentric axles for ease of moving about. When these wheels are lowered, the conveyor is easily rolled from place to place, and when they are lifted up, the conveyor rests firmly on the floor. Ease of cleaning and freedom from rusting make it ideal for use where liquids are apt to be spilled from open containers. Conveyor can be



supplied with or without legs, and with or without wheels. Model shown is 10 ft. long, 14 in. wide, and weighs only 60 lb.

"Markwell" Stamp Holder Features Unique Design

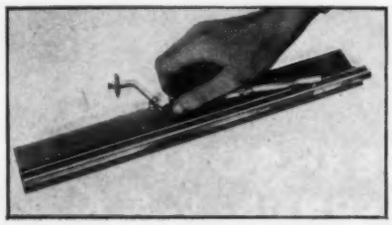
The usual process of employing springs, clips, pins, cams or rivets in a steel stamp holder body has been eliminated by the use of a self-contained locking pin carrying its own spring for holding the type in place in the steel type holder made by the Pittsburgh Stencil & Tool Co., 405 Penn Ave., Pittsburgh, Pa. Large holes and heavy anvils have also been



eliminated by the use of a thin tempered anvil which requires no rivets or screws to hold it in place against the chrome nickel body. The holder can be made for any reasonable number and size of characters required.

Dietzgen Lettering Set Uses Single Guide

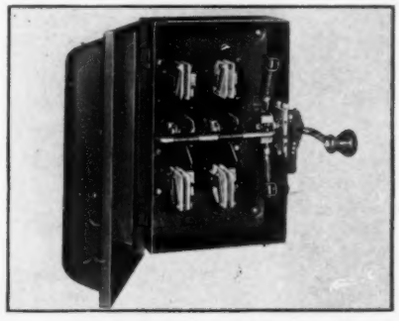
An outstanding feature of the "Spee-Dee" lettering set produced by the



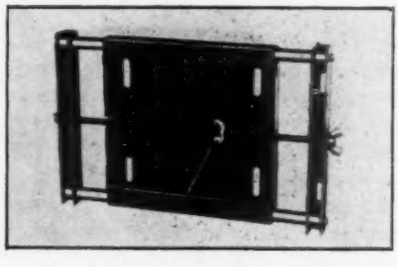
Eugene Dietzgen Co., 2425 Sheffield Ave., Chicago, Ill., is that with one single guide it is possible to produce eight different types of lettering simply by changing the setting of the tracer and the pen arm. Letters are formed in one continuous movement without shifting the guide, as each character on the guide is complete. Each outfit has six different weights of pen points ranging from extra light to extra bold, and is packed in a portable mahogany case with all supplies.

Double-Throw Switches Have Cover Interlock

A line of unfused Type A double-throw switches with quick make-and-break construction has been announced by the Square D Co., Detroit, Mich. These switches are of unit-base construction, having a V-



type blade, multi-spring jaws and the compression spring construction of Square D quick make-and-break mechanisms. A cover interlock is provided and padlocking positions are provided for three padlocks in the off and both on positions. They are available in 60, 100 and 200 amp. sizes with either two or three poles.



"Automatic" Motor Base Holds Belt Tension

Correct belt tension is constantly maintained in the "Automatic" tension motor base announced by the Ideal Commutator Dresser Co., 1057 Park Ave., Sycamore, Ill. These units are suitable for horizontal, vertical,

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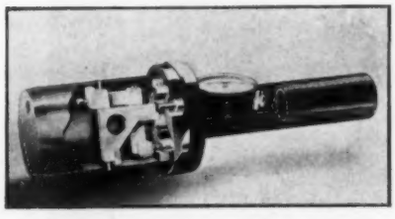
and overhead drive, and are claimed to operate satisfactorily with any type of load, whether pulsating, steady or reversing. To take up belt slack, it is only necessary to give the adjusting screw a few turns. This same adjustment makes changing of belts especially easy. Motor is mounted directly on the sliding tape of the base, then motor and base bolted down as a unit.

Indicator Plug Gage Checks Bores

The principal function of the indicator plug gage announced by Sheffield Gage Corp., Dayton, Ohio, is the checking of cylindrical bores during finishing operations. It is equally useful for final inspection. It can be read to "tenths" of an inch and interpolated to fractional tenths.

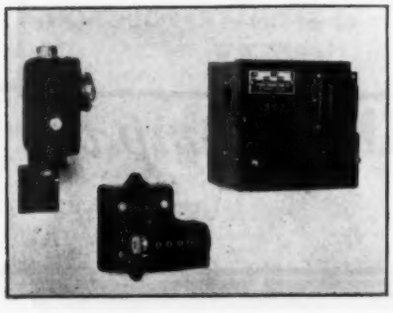
The reed mechanism used in other Sheffield gages is incorporated in this unit, which carries two gaging points diametrically opposite each other,



both freely moving in correlation with each other. Thus any irregularity on either side of the bore is indicated on the dial, and correctly evaluated. Effects of thrust pressure between plug and gage are minimized.

Photo-Electric Counter Features Compact Design

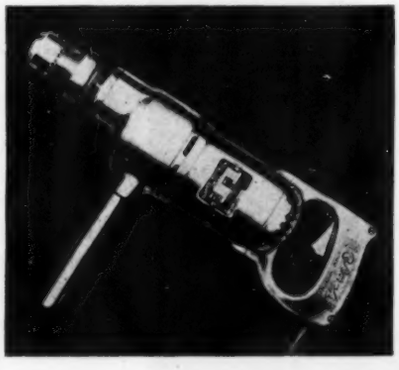
The photo-electric amplifier contact relay unit, terminal board and power transformer for amplifier and light source are all mounted as integral parts of the photo-electric amplifier unit cover of the Model 566 photo-electric counting equipment developed by the Lipman Engineering Co., 415 Van Braam St., Pittsburgh, Pa. Cell is mounted 4 in. from opening to minimize the effect of stray light. A sensitivity control is provided, enabling unit to operate on visible or invisible light. This unit is tested for speed of counts up to 600 per min.



Type "MO" Breaker Offered by Colt

Designed especially for low amperage applications in the average shop, the Type "MO" Multi-Breaker, made by

Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., has been simply built to provide foolproof operation. When current is broken by either short circuit or overload, movement of the handle will restore power after cause of the interruption has been removed. Handle is claimed not to trip on a momentary overload. Unit is available for 150-230 volts, 2-pole or 3-pole solid neutral, at 15, 20 or 25 amp.



Portable Drills Have Double Reduction

Double reduction keeps the offset distance from top of the motor housing to center of the drill bit at a minimum in the ½-in. "Utility" portable electric drill manufactured by the James Clark, Jr. Electric Co., 600-640 E. Bergman St., Louisville, Ky. Providing a no-load drill speed of 650 r.p.m. and an approximate full-load speed of 300 r.p.m., the drill has been equipped with ball bearings on the armature, both intermediate gears and spindle for maximum efficiency. Over-all length is 15⅞ in., and net weight is 9½ lb. Models are available for 110, 220, or 250 volts a.c. or d.c.

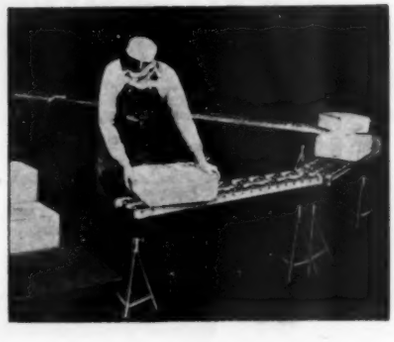
Battery Cell Tester Has Adjustable Prods

Replacing at a lower price a former tester which was not adjustable, the No. 3,126,754 battery cell tester introduced by the General Electric Co., Schenectady, N. Y., is of modern design featuring adjustable prods which

enable it to fit any battery cell. Permanently fixed to the prods is an S-shaped resistance which acts both as a load supplier and also as a spring for prod adjustment. Meter is located on top of the handle to provide best visibility.

Portable Conveyor Has Light Weight

Weighing only 6.6 lb. per ft., a line of portable wheel conveyors has been made available by the Metzgar



Co., Grand Rapids, Mich. These conveyors are of welded construction, giving maximum strength and rigidity. Couplings are simple and protected against bending. Conveyors do not require lubrication, as all wheel bearings are dust-proof and have hardened ball races. They are claimed to be more quickly assembled than other types, as straight lengths can be coupled at as much as a 40 deg. angle without using a curved section. Each stand has three legs instead of four, providing a firm support even when floors are not level.

Pointer-Stop Instruments Make Quick Measurements

Because conventional ammeters and voltmeters require over a second to reach a proper indication while some applications require a reading in a fraction of a second, the General Electric Co., Schenectady, N. Y., has developed a line of Type AP-9 pointer-stop instruments for measuring currents or voltages of short duration. These instruments are equipped with an adjustable stop, micrometer screw actuated, arranged to push the pointer either upscale or downscale. Measurements are made by successively setting the stop until a position is reached where the indicating pointer barely moves in response to a current or voltage impulse. The instrument then indicates the proper value. Typical applications of the new instruments are in measuring welding current, motor-starting current, and voltage dip.

"Ful-Vue" Goggles Offered In Improved Bridge Type

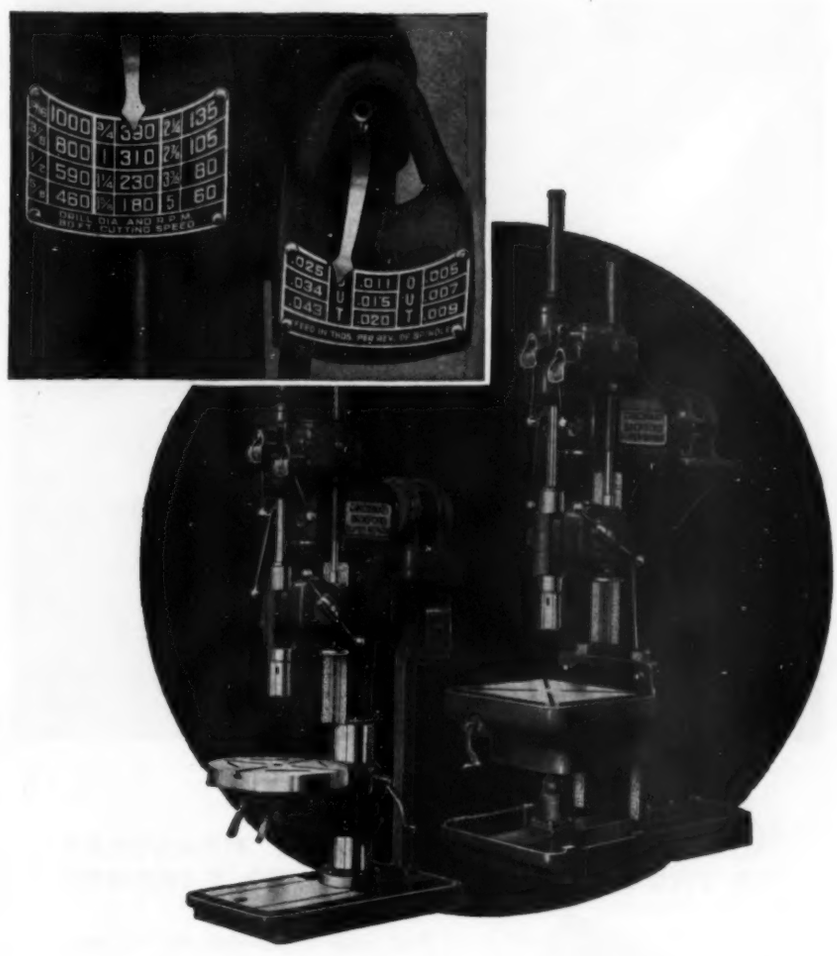
Available in a new range of three eye and three bridge sizes, the "Ful-Vue" safety goggles made by the American Optical Co., Southbridge, Mass., are now being supplied with an improved double-braced bridge or nosepiece. Improved construction consists of soldering the bridge to the lens frame at four places instead of the conventional two, resulting in a sturdy design which assures longer service under hard use.

Arc Welding Electrode Minimizes Seam Dressing

Developed particularly for U-groove finish welding in downhand position, the "Fleetweld 10" arc welding electrode developed by the Lincoln Electric Co., 12818 Coit Road, Cleveland, Ohio, is claimed to facilitate finishing operations by eliminating the need for dressing or smoothing welded seams in many applications. The electrode provides full slag coverage and a weld deposit of exceptional smoothness, the bead being uniform and regular without square shoulders. Metal smooths out evenly during welding and it is said the line of fusion with the base metal is practically unnoticeable. Finish beads flush with the plate surfaces can be made in V-butt joints in flat position. "Fleetweld 10" can be used with either a.c. or normal or reverse polarity d.c.

Atlas Synthetic Cement Is Corrosion Resistant

"Korez" synthetic resin cement, developed by the Atlas Mineral Products Co., Mertztown, Pa., is applied as a mortar which quickly sets by chemical action at room temperature to a dense, strong jointing material. When used as an acid tight jointing material for acid-proof brick, Korez has successfully solved corrosion and maintenance problems in the construction of acid pickling tanks, acid neutralization and disposal equipment in steel



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THE CINCINNATI BICKFORD TOOL CO.
OAKLEY CINCINNATI OHIO U.S.A.

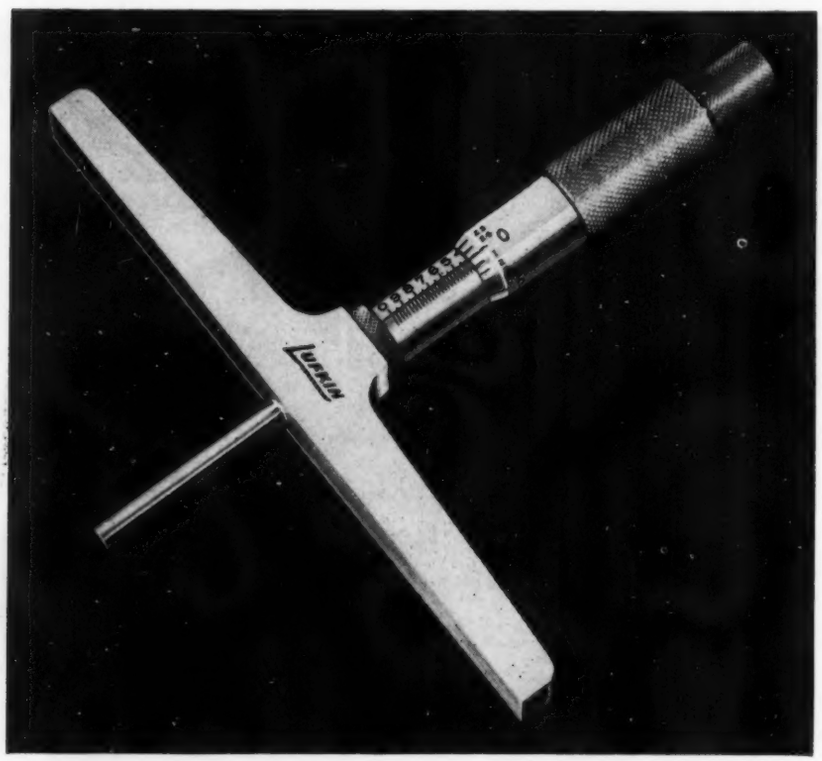
and allied industries. As it is impervious and inert to all acids, except those that are highly oxidizing, and is inert to oil, water and mild alkalies at temperatures up to 330 F., this cement has a number of industrial applications.

TRADE PUBLICATIONS

BORING MACHINES Features of the "Triway" 3-in. spindle horizontal boring machine are described and illustrated in an eight-page folder issued by the Universal Boring Machine Co., Hudson, Mass.

CONTACTS "Dust the Destroyer," a 24-page illustrated booklet offered by Cutler-Hammer, Inc., 315 N. Twelfth St., Milwaukee, Wis., discusses features of a line of vertical contacts for use in dust-laden air.

FLOORING "Rockflux" acid resistant floor resurfacer is described in a folder offered by the Flexrock Co., 23rd & Manning Sts., Philadelphia, Pa.



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MICROMETER DEPTH GAGE MEASURES IN THOUSANDTHS FROM 0 TO 6 INCHES

Each gage is provided with six rods. Each thousandth is numbered for quick, accurate reading, and the exclusive, patented lock nut locks rod at any point to maintain reading. The five inch base is hardened and ground and has knurled surface on top affording firm hold. This is without doubt the finest depth gage made.

BUY THROUGH YOUR DISTRIBUTOR

NEW YORK 106 Lafayette St. | THE LUFKIN RULE CO. SAGINAW, MICHIGAN | Canadian Factory WINDSOR, ONT.

INSTRUMENTS A line of multiple-record strip-chart pyrometers is described in Bulletin No. 528 issued by the Bristol Co., Waterbury, Conn.

LATHES A 12-page illustrated bulletin, Form No. 391, describing the features of Models 8, 10, and 12 automatic stub lathes is offered by the Sundstrand Machine Tool Co. Harrison & 11th Sts., Rockford, Ill. Copies should be requested on business letterhead.

MASONRY DRILLS A wall chart now being distributed by the Super Tool Co., 21650 Hoover Road, Detroit, Mich., tabulates correct masonry drill sizes for an extensive number of makes and types of expansion shields and plugs.

MOTORS A leaflet discussing a line of small single-phase motors is now being distributed by Sterling Electric Motors, Inc., 5410 Telegraph Road, Los Angeles, Calif.

PIPE THREADING The Oster Mfg. Co., 2057 E. 61st Place, Cleveland, Ohio, has announced publication of Catalog No. 39-A covering die-stocks and portable pipe threading machines. This 32-page catalog is fully illustrated and gives specifications for each of the machines described.

PLASTICS "Practical Methods of Machining Bakelite-Laminated and How to Apply Them in Your Own Shop" is the title of an illustrated folder issued by Synthane Corp., Oaks, Pa.

PLATING A technical service bulletin made available by the Electroplating Div., E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., contains eight pages of recommendations for the preparation and maintenance of "Cadalyte" plating solutions.

POLISHING A well illustrated eight-page bulletin showing various types of round, out-of-round, flat, tapered, tubular and irregular contoured work being polished and buffed by new semi-automatic polishing and buffing heads for use with double spindle lathes is offered by the Industrial Equipment Div., Continental Roll & Steel Foundry Co., 14400 Railroad Avenue, East Chicago, Ind.

PORTABLE TOOLS Catalog No. 39, published by the Jas. Clark, Jr., Electric Co., 600 E. Bergman St., Louisville, Ky., provides 32 pages of information concerning a line of portable drills and grinders.

PUMP ACCESSORIES Leaflet SP-1, issued by the De Laval Steam Turbine Co., Trenton, N. J., discusses submerged suction priming equipment for use with many types of hydraulic pumps.

PRESS BRAKES Bulletin No. 74-A, issued by the Niagara Machine & Tool Works, 637–697 Northland Ave., Buffalo, N. Y., contains 18 pages of illustrations, specifications and other information concerning an extensive line of folders and brakes.

PRESSES Features of a line of "streamlined" high production hydraulic presses are provided in an illustrated folder, No. 139, offered by the Lake Erie Engineering Corp., Buffalo, N. Y.

ROLLER BEARINGS Features of a line of roller bearings for railroad car journals are discussed in a 48-page illustrated catalog published by the Hyatt Bearings Div., General Motors Sales Corp., Harrison, N. J.

"ROTO SHAVING" An illustrated folder now being distributed by the National Broach & Machine Co., Shoemaker & St. Jean Sts., Detroit, Mich., discusses the "Roto Shaving" of finish machining.

SAFETY The Model 1001 "Flameotrol" combustion safeguard is described in leaflet No. 1001-1, offered by Wheelco Instruments Co., 1929 S. Halsted St., Chicago, Ill.

SCREW MACHINES Sheet No. 7 in the series "To The Automatic Screw Machine User" has been issued by Banner Mfg. Co., 1873 Clybourn Ave., Chicago, Ill.

STEELS The No. 2, 1939, Stock List & Steel Data Book published by Joseph T. Ryerson & Son, Inc., 16th & Rockwell Sts., Chicago, Ill., includes a detailed listing of many new products and sizes added to the company's line of "Certified" steel products, giving weights, lengths, cutting data and other essential information.

TACHOMETER Herman H. Sticht, & Co., 27 Park Place, New York, N. Y., discusses features of the "Standco" hand tachometer in a 4-page illustrated folder, Bulletin No. 720.

THREADING MACHINES Bulletin No. H-75-4, issued by the Landis Machine Co., Waynesboro, Pa., contains 16 pages of features and specifications of the "Landmaco" line of threading machines.

SEEN and HEARD

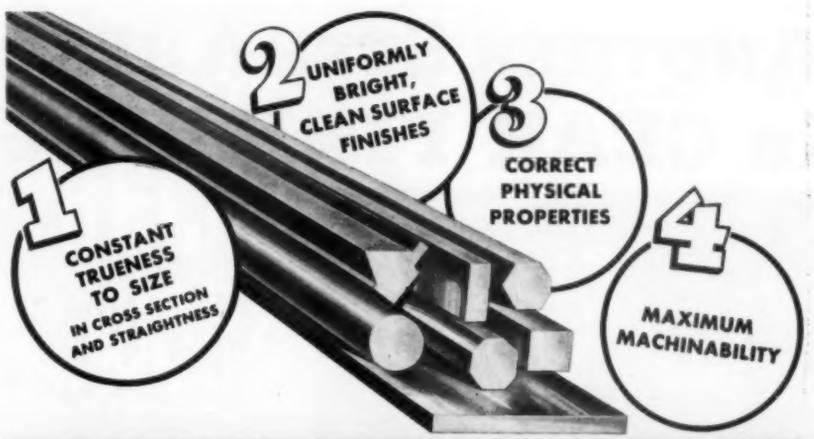
JOHN R. GODFREY

Concrete's New Rival

We've thought for some time that concrete was the last word in machine tool foundations. Now welded steel shapes are being used with satisfactory results. In one case, 4-in. steel plates, weighing 31,000 lbs., were welded into a sort of cellular base. The wood-block flooring was removed and an inch of concrete poured over the cleared space, and the steel base laid on the wet cement. This held a Keller machine weighing 42,000 lbs. and was so satisfactory that steel has now replaced three concrete foundations.

Blank Battle

Some years ago cast iron and steel gave way to forgings as materials for gear blanks, particularly where the service was severe. Now forgings are being challenged both by castings and by welded shapes. Ford is casting ring gear blanks centrifugally of steels



Year 'Round Characteristics of all

WYCKOFF

COLD DRAWN STEELS

Once you have determined the size, shape and physical characteristics of the steel you require for your particular requirements, you can depend on Wyckoff to meet your cold drawn steel needs with the precision of a laboratory formula. Remember, every length of Wyckoff Cold Drawn Steel is the product of progressive scientific metallurgical control from the molten metal to the finished bar—every length backed by a complete history of its physical and chemical pedigree. Absolute uniformity, bar after bar, is the result . . . . correct in analysis, size, straightness and a smooth, bright surface and superior machining qualities that will go far in reducing your production costs to the absolute minimum.

WYCKOFF

DRAWN STEEL COMPANY

First National Bank Bldg. PITTSBURGH, PA.

3200 So. Kedzie Avenue CHICAGO, ILL.

Mills at Ambridge, Pa. and Chicago, Ill. . . . Warehouse Stocks in Principal Cities . . . Manufacturers of Carbon and Alloy Steels . . . Leaded Steels . . . Turned and Polished Shafting . . . Turned and Ground Shafting . . . Wide Flats up to 12" x 2"

similar to that used in his crankshafts. Needless to say the steel used in modern castings is very different from that of say fifty or even twenty years ago. And gear blanks of almost any size are now being welded, ready for cutting. The weights run up to 10,000 lbs. and are usually lighter than either forgings or castings. Furthermore, they require neither patterns nor forging dies.

Trying it Again

Methods come and go, much as fashions in women's hats. Sizing holes by forcing steel balls through them is one that comes and goes. The Graham shop used it years ago to size the holes in valve lifter guides, six at one shot. It worked fine—but was abandoned in a year or two. The reason given was that the holes were not always straight — the balls crowded over wherever the metal was softer than the rest. Last year some other shops took it up and pronounced it O.K. Perhaps the castings were more uniform.

Railroads, however, are using the same sizing idea but with hardened steel plugs instead of balls. They force them through driving-wheel hubs and crankpin holes. The method sizes the holes, smooths down any fuzz that may be left by the tool and also cold works the metal by stretching it, adding to its strength. High speeds and heavy trains make more and more care necessary.

Malleable Comes Back

Pressed steel and welded joints have replaced castings in many structures. Combinations of steel plates and castings have done still more to show the progress of the welders art. But they are not to have undisputed possession of all the fields into which they have gone. The Malleable Founders Society are not content to let steel have all its own way. In a recent job the use of malleable castings saved $6 on a battery rack that formerly cost $23.50 when made of steel shapes and welded. And the malleable people are going after such work as differential housings for automobile axles, which slipped away from them a few years ago to forgings and to steel castings. That is the way we progress.

ANOTHER STEP AHEAD in GEAR FINISHING

The New Cone-Drive "860" Gear Finisher

By incorporating a new drive mechanism, using the spectacular new "Cone" area-contact worm gearing, the "860" crossed-axis gear finsher will now shave gears to even smoother finish and to half the normal tooth variations.*

Designed for the manufacturer whose problems include the producing of job-lots or many different sizes and types of gears, the "860" has the advantages of low initial cost for machine and tooling.

It is fast in operation—upwards of 30 gears per hour; remarkably quick to set up and change over; capable of producing hundreds of spur and helical types with but a few cutters; permits using Class B hobs for semi-finishing.

Would you like more information on this development? Drop us a line.

** In addition, numerous other improvements have been made to increase productivity, cut set-up time, simplify maintenance and increase life.*

MICHIGAN TOOL COMPANY 7171 E. McNichols Rd. Detroit, Michigan

Please send me your Bulletin No. 860(A).

Name ..... Title .....

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For Cleaning Lenses

Recommended by the Glycerine Producers' Association for cleaning spectacle lenses, the following simple glycerine-containing preparation also is suitable for cleaning glass of all sorts, including windows and mirrors. It is said to help prevent clouding and steaming on the glass. The preparation is made by melting 1 oz. of glycerine and 2 oz. of potassium oleate together on a water bath, then adding 1 dr. oil of turpentine. The thickness of the paste can be adjusted by adding glycerine.

Wedding Present on Wheels

The Crown Prince of Iran, son of the Shah of Persia, and the sister of King Fuad, who were recently married, received among their wedding presents a motor caravan made by the Eccles Company in Birmingham, England. The vehicle, according to *Industrial Britain,* is a mobile butler's pantry and cocktail bar, designed to cater for 40 people. It is fitted with water tanks, three large oil stoves, large refrigerating units, stainless steel sinks with water on tap, numerous cupboards, all of which are rubber lined and will carry upwards of 1,000 cooking and other utensils. Mosquito netting covers all doors and windows.

Odd Engines

Edwin Kilburn mentions an odd engine that furnished power for the North Star Iron Works (*AM*—Vol. 83, page 29).

This sounds like the old Baxter engine, built, I think, in Baltimore, in which the single vertical cylinder was inside the upper end of a vertical boiler. The reason for this cylinder location was to jacket the cylinder with live steam and to secure a compact unit. The usual plan, however, was to drive the line shaft by a belt.

The only direct-coupled engine I ever saw was in the old Colt's Armory in Hartford. Here the vertical Porter-Allen high-speed (for those days) steam engine was coupled directly to the lineshaft. The engine was in the center of the long shop with the lineshaft extending in each direction.

The lineshaft was a series of cast iron drums, about 12 in. in diameter, being "necked" down at the bearings. The object was to avoid the use of pulleys by belting directly on the shaft. Need for increased speed of some machines soon led to "lagging" the drum in places and finally to its abandonment.

Uncle John

By H. M. LANE

When I was about sixteen years old I attended an engineering meeting with my father.

Many noted engineers were present, and I was interested in the papers and discussion.

When the meeting was adjourned at noon for lunch, I walked up to John Fritz, of the Bethlehem Steel Company, to ask him a question.

I started in "Mr. Fritz," but he cut me short with "Henry, stop that."

I said, "What have I done, Mr. Fritz?"

He said, "There it goes again. Never call me Mr. Fritz; call me Uncle John, as my boys (about everyone associated with him) do."

So from that day until he died, past 85, to me he was always Uncle John, and I treasure many pleasant memories of him.

Saws for Cutting Metal

C. G. WILLIAMS

I have been in the toolrooms and production divisions of large shops, where the attention or rather non-attention paid to saws for metal cutting should be classed as a crime.

How often have I seen saws with teeth improperly sharpened sent out from toolrooms as production saws. Who cares? Only the man on the machine who can't hold up production rates. Only the gang foreman who gets jacked up for falling down on production. And so on up to the superintendent who sees the line stop for lack of parts.

Who is responsible that for the petty sum of $350 the shop does not have a saw sharpening machine that will hold the tooth to shape for months instead of a few hours? And another item of saw loss—not designing tools to use saws of smaller diameter in progressive steps.

Yale and Towne now stamp the letter Y on every link of the chain made for use in their hoists. This removes all chance of argument as to whether or not they made chain that may have been unsatisfactory in service. Since marking their chains with positive identification, chain complaints have nearly vanished.

MORE PRECISION WORK

With Rivett Spring Tempered COLLETS

A set of spring tempered collets and draw-in attachment can improve the production and precision work on any engine lathe. This quick, accurate method of chucking bar stock and odd shaped parts is a guarantee for **MORE PRECISION WORK.**

The collet attachment and any style collets can be furnished from stock. Write for bulletin 100-b and print to be filled in with the required spindle dimensions.

RIVETT LATHE & GRINDER INC.
Brighton, Boston, Mass.

RIVETT

Suggestions on forging highly alloyed tool steels

Heating for forging

Tool steels of this type conduct heat slowly. For this reason tool steel should be slowly heated and soaked in a preheating furnace prior to charging into the high-heat forging furnace. A preheating range of from 400 deg. F. to 800 deg. F. below forging temperature is recommended to avoid scaling and decarburization.

After the steel is transferred to the high-heat furnace it should be brought quickly to uniform forging heat and removed immediately to prevent excessive scaling, decarburization and grain growth. Direct impingement of flame upon the steel should be avoided. Furnace atmosphere should be kept neutral or slightly reducing.

If a preheater is not available, heat the steel slowly in the forging furnace and soak at a temperature between 400 deg. F. and 800 deg. F. below forging temperature. Then bring the furnace rapidly to forging temperature and remove the steel for forging when it becomes uniformly heated.

As an added precaution before charging into the furnace, it is suggested that the steel be warmed by placing it either on the top of the furnace or on the shelf in front of the charging door so that the chill is removed.

Forging

The hammer should be of proper capacity to thoroughly work the steel throughout its section. Too light a hammer may not work the center of the steel. Too heavy a hammer may cause ruptures.

The first series of hammer blows should be light to avoid tearing the steel. Speed and power of blows may be safely increased as forging progresses. The forging reductions should be in successive squares, knocking down corners after each reduction to avoid tearing. When forging rounds from squares, "V" type dies are recommended to prevent center ruptures.

Cooling after forging

Tool steels of this type air-harden to a certain extent and should be cooled slowly in silocel, dry lime or ashes to minimize forging and cooling strains. Unusually intricate parts should be given a stress-relieving anneal immediately after forging and all high speed steels should be annealed after forging. If a previously hardened tool is salvaged by reforging to make a smaller tool it should first be annealed.

Bethlehem furnishes a complete selection of tool steels to handle every type of metal-working. Write for a free copy of the Bethlehem Tool Steel Guide. It contains information on how to choose the proper steel for any need.

BETHLEHEM STEEL COMPANY

BETHLEHEM STEEL